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A Remedial Investigation was conducted at the Great Falls Air National Guard Base during April, May, and July 1996. During the period four IRP sites were investigated (IRP Sites 1, 6, 7, and 8). The investigation consisted of drilling 14 soil borings and installing 10 monitoring wells.

At Sites 1 and 6, no contaminants in the soil or groundwater were found above State and Federal cleanup levels; and a Decision Document to support no further action is recommended. At Sites 7 and 8, no contaminants were found in the soil above State and Federal cleanup levels; and a Decision Document to support no further action with respect to soil contamination is recommended. At Sites 7 and 8, groundwater contamination above State and Federal cleanup levels was detected. The contamination included petroleum hydrocarbons, chlorinated solvents, and dissolved metals. It is recommended that an Engineering Evaluation/Cost Analysis be prepared to evaluate remedial alternatives for the groundwater at Sites 7 and 8.

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**FINAL  
REMEDIAL INVESTIGATION REPORT**

**120TH FIGHTER WING  
MONTANA AIR NATIONAL GUARD  
GREAT FALLS INTERNATIONAL AIRPORT  
GREAT FALLS, MONTANA**

**VOLUME I**

**MAY 1997**

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## ACRONYMS AND INITIALISMS

AGE	Aerospace Ground Equipment
ANG	Air National Guard
ANGB	Air National Guard Base
ANGRC	Air National Guard Readiness Center
ARARs	applicable or relevant and appropriate requirements
AWQC	Ambient Water Quality Criteria
bgs	below ground surface
BRA	baseline risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	<i>Code of Federal Regulations</i>
CLP	Contract Laboratory Procedure
COC	chain-of-custody
COPC	contaminants of potential concern
CSF	cancer slope factor
CWA	Clean Water Act
DD	Decision Document
DO	dissolved oxygen
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
EE/CA	engineering evaluation/cost analysis
FCR	Field Change Request (form)
FFS	Focused Feasibility Study
FG	Fighter Group
FS	Feasibility Study
FTA	Fire Training Area
FW	Fighter Wing
GC	gas chromatograph
GPR	ground-penetrating radar
HAZWAP	Hazardous Waste Remedial Actions Program
HHS	Human Health Standards
HMTC	Hazardous Materials Technical Center
ID	inside diameter
IDW	investigation-derived waste
IRP	Installation Restoration Program
JP	jet propellant
LEL	lower explosive limit
LNAPL	light nonaqueous phase liquid
LOAEL	lowest observed adverse effect level
MCL	maximum contaminant level
MCLG	maximum contaminant level goals
MDEQ	Montana Department of Environmental Quality
MDHES	Montana Department of Health and Environmental Services
NCP	Oil and Hazardous Substances National Contingency Plan
NOAEL	no-observed adverse-effect level

NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbidity unit
OD	outside diameter
OSHA	Occupational Safety and Health Act
PA/SI	Preliminary Assessment/Site Inspection
POL	petroleum, oil, and lubricants
PPM	priority pollutant metals
PPR	personal protective equipment
PRE	preliminary risk evaluation
PRG	preliminary remediation goal
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QC	quality control
RA	Remedial Action
RBC	risk-based concentrations
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RI	Remedial Investigation
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SI	Site Investigation
SVOC	semivolatile organic compound
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TOC	total organic content
TPH	total petroleum hydrocarbons
TSD	treatment, storage, and disposal
UST	underground storage tank
VOC	volatile organic compound
WP	Work Plan

## EXECUTIVE SUMMARY

This Remedial Investigation (RI) report has been prepared as part of the Installation Restoration Program (IRP) for the 120 Fighter Wing, Montana Air National Guard, Great Falls International Airport, Great Falls, Montana. The primary objectives of the RI report were to complete the characterization of the nature and extent of confirmed contamination and to evaluate the risks posed to human health by any soil and groundwater contamination present at three sites.

The three sites evaluated are:

- Site 6 - Aerospace Ground Equipment (Building 22) Area,
- Site 7 - Dry Well Off Corrosion Control Building (Building 23), and
- Site 8 - Dry Well Off Composite Maintenance Building (Building 32).

A supplemental groundwater investigation at Site 1 is also included in the RI.

The Montana Air National Guard Base is located at the Great Falls International Airport 3 miles southwest of the City of Great Falls. The Base is located on the Sun River bench, a topographic plateau situated about 350 feet (ft) above the surrounding plains, at the confluence of the Sun and Missouri Rivers.

A Preliminary Assessment (PA) in 1988 identified eight sites where justification existed to collect additional data to confirm or deny potential contamination from Base activities. In 1989 a Site Investigation was initiated to investigate the eight sites cited in the PA. Based on the results of the investigation, four of the eight sites were recommended for Decision Documents (DDs) for no further action for both soil and groundwater. An RI was recommended for Sites 6, 7, and 8; an additional monitoring well was recommended for Site 1. A source removal action was carried out for the soils at Site 1, and the no further action alternative was accepted by the Montana Department of Environmental Quality.

The geology of the Base is characterized by a surficial layer of soil and weathered sandstone that commonly is 2 to 3.5 ft thick but ranges to as much as 20 ft thick. The unconsolidated and weathered deposits are underlain by more-competent sandstones of the Cretaceous age upper Flood Member. The fine-grained sandstones of the Flood Member are identified as the groundwater aquifer at the Base.

The RI field program was conducted in April and May, 1996; a follow-up second round of groundwater sampling was performed in July 1996. Confirmation activities included the drilling of 14 soil borings at the three sites, the drilling and installation of 10 monitoring wells, and the collection of 3 sediment samples. All soil borings were advanced to refusal, and three samples were collected from each boring. In addition to the soil samples and groundwater samples collected for laboratory analysis, information on soil properties and hydrogeologic data was collected. These data include geotechnical sampling, hydraulic conductivity tests, and groundwater elevation measurements.

Monitoring wells were drilled to a depth of between 45 to 60 ft below ground surface to a dark gray sandstone. Entry of water into the monitoring wells was slow and is believed to be through small fractures, along with intergranular porosity. Potentiometric maps prepared from the groundwater elevation data indicate a Basewide flow direction to the northwest that transitions to the west in the vicinity of Site 7. Anomalies in the flow pattern are attributed to localized variations in permeability.

Hydraulic conductivities from slug test data averaged  $2.38\text{E-}2$  ft/min. These data appear higher than anticipated and are believed to reflect the fractured nature of the bedrock. Calculated groundwater flow velocities based on the slug test data are believed not to accurately represent actual site conditions.

Site 1 At Site 1 only very low concentrations of organic compounds and metals were detected in groundwater. The source of these compounds and metals do not appear to be site related, and none of the detections were above State or Federal maximum contaminant levels (MCLs). Preparation of a DD to support no further IRP action for groundwater is recommended.

Site 6 At Site 6, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), petroleum hydrocarbons, and metals were detected in the soil profile. The highest concentrations of contaminants were found in the boring drilled at a presumed dry well location and the adjacent boring. Soils in the vicinity of a presumed dry well are paved with asphalt. The preliminary risk evaluation (PRE) performed for the soils indicates the concentration of contaminants and expected exposures do not exceed the criteria for threats to human health. Preparation to support a DD for no further action for Site 6 soils is recommended.

Sediment samples were collected from the drainage ditch at the site. One SVOC compound—benzo(a)pyrene—was detected in the drainage ditch at concentrations exceeding the Region IX preliminary remediation goal (PRG) by less than 1.5 times. The detected concentration is still within the  $10\text{E-}6$  risk range and should not pose an unacceptable human health risk. The contents of an additional dry well investigated at the site should be removed and properly disposed.

None of the low-level concentrations of VOC and SVOC compounds detected in the groundwater exceeded Federal or State applicable or relevant and appropriate requirements (ARARs). Metals were also below ARARs. Preparation of a DD for no further IRP action is recommended for the groundwater at the site.

Site 7 At Site 7, the level of VOC and SVOC soil contamination was relatively low. Concentrations of fuel-related VOCs were highest in samples from the soil boring closest to the dry well. Fuel-associated SVOC compounds and petroleum hydrocarbons were present—primarily in the samples taken at auger refusal. Four metals were detected above background, and two metals were detected that were not present in the background samples. The PRE for the soil at Site 7 indicates chloroform is the only analyte whose concentration exceeds the Region IX PRG. The maximum detected concentration of 0.73 ppm however only exceeded the Region IX PRG by 0.20 ppm. The PRG was calculated based on a target risk value of  $10\text{E-}6$ ; at this concentration, the risk is still within the  $10\text{E-}6$  range. None of the other contaminants exceed the PRE criteria. No further action is recommended for Site 7 soils.

Numerous VOCs were detected in both rounds of Site 7 groundwater samples. The concentration of one VOC, benzene, was greater than State and Federal ARARS. The single occurrence of benzene above the State and Federal MCLs of 0.005 ppm was at a concentration of 0.0055 ppm. SVOCs were generally nondetects except in one well that had six PAHs above State and Federal ARARS. These detections were qualified values in the 0.001 to 0.002 ppm range. Metals were present, but none exceeded State or Federal MCLs. Between 1.1 and 1.3 ft of free product was found in one well, 7MW-1. It is recommended that an engineering evaluation/cost analysis (EE/CA) be prepared to evaluate potential remedial alternatives for the groundwater at the site.

Site 8 At Site 8, VOCs, SVOCs, petroleum hydrocarbons, and metals were detected in the soils. Four metals were above background values; three additional metals were present but within anticipated concentration ranges for the western United States. Based on the results of the PRE, which indicated the soils do not exceed criteria for threats to human health, no further action is recommended for the soils at the site.

Results from the groundwater indicated the presence of a variety of chlorinated compounds, three of which were above State and Federal MCLs. Cis-1,2-dichloroethene was detected at a maximum concentration of 0.83 ppm. State and Federal ARARs for this analyte is 0.070 ppm. TCE was detected at a maximum concentration of 0.055 ppm. State and Federal MCLs are 0.005 ppm. Tetrachloroethene was present at a maximum concentration of 0.018 ppm; State and Federal MCLs are 0.005 ppm. Two metals were detected at concentrations above or equal to State and Federal ARARs. The extent of groundwater contamination was not fully evaluated, and an EE/CA is recommended to evaluate potential remedial measures at Site 8.

## 1. INTRODUCTION

This report documents the Remedial Investigation (RI) activities conducted at the 120th Fighter Wing (FW), Montana Air National Guard, Great Falls International Airport, Great Falls, Montana, hereafter referred to as the Base. The RI was performed under the U.S. Department of Defense (DOD) Installation Restoration Program (IRP). The Air National Guard (ANG) has established the Air National Guard Readiness Center (ANGRC) to oversee implementation of the IRP at ANG installations. The ANG has entered into an interagency agreement with the U.S. Department of Energy (DOE) under which DOE provides technical assistance in implementing the IRP. Lockheed Martin Energy Systems, Inc., under contract with DOE, provides the technical assistance for the IRP under the interagency agreement through its Hazardous Waste Remedial Actions Program (HAZWRAP) division.

### 1.1 INSTALLATION RESTORATION PROGRAM OBJECTIVES AND SEQUENCE

The DOD initiated the IRP in 1976 to identify, evaluate, and remediate suspected environmental problems associated with past usage, storage, handling, and disposal of hazardous substances at DOD facilities. The guidelines for the assessment and cleanup of nonactive (historic) contaminated sites were promulgated by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. This act was reauthorized and expanded upon by Sect. 120 of the Superfund Amendments and Reauthorization Act (SARA) of 1986, which required that IRP activities adhere to procedures specified in the Oil and Hazardous Substances National Contingency Plan (NCP) Final Rule; 40 *Code of Federal Regulations* (CFR) Pt. 300. The NCP details a sequence of steps to be followed when investigating and cleaning up suspected hazardous waste sites. This sequenced begins with the discovery of a suspected hazardous waste release or threat of release and ends with a permanent remedy to eliminate or minimize the environmental impact and long-term monitoring of the remediation effort. The NCP serves as the primary basis for the IRP. The sequential phases that constitute the DOD IRP process and the purpose and activities associated with each phase are presented in Fig. 1.1 and are summarized below.

- **Preliminary Assessment/Site Inspection** A Preliminary Assessment (PA) is performed to identify and evaluate the type and location of suspected problems associated with past hazardous waste handling procedures, disposal sites, and spill sites. This is accomplished through interviews with past and present installation employees, historical records searches, and visual site inspections. In addition, detailed geologic, hydrologic, meteorologic, land use, and environmental data for the study area are gathered. A detailed analysis of all information obtained identifies sites of concern. The PA for the 120th Fighter Wing, Montana Air National Guard Great Falls International Airport, was completed by the Hazardous Materials Technical Center (HMTC) in 1988 and identified eight sites requiring further action.
- **Site Investigation** The purpose of a Site Investigation (SI) is to acquire the data necessary to either confirm the presence or absence of suspected environmental contamination at each identified site of concern. The SI can be expanded (if sufficient data are collected) to provide a preliminary evaluation of the potential risks to human health, welfare, and the environment. The SI includes identification of specific chemical contaminants and their concentrations in

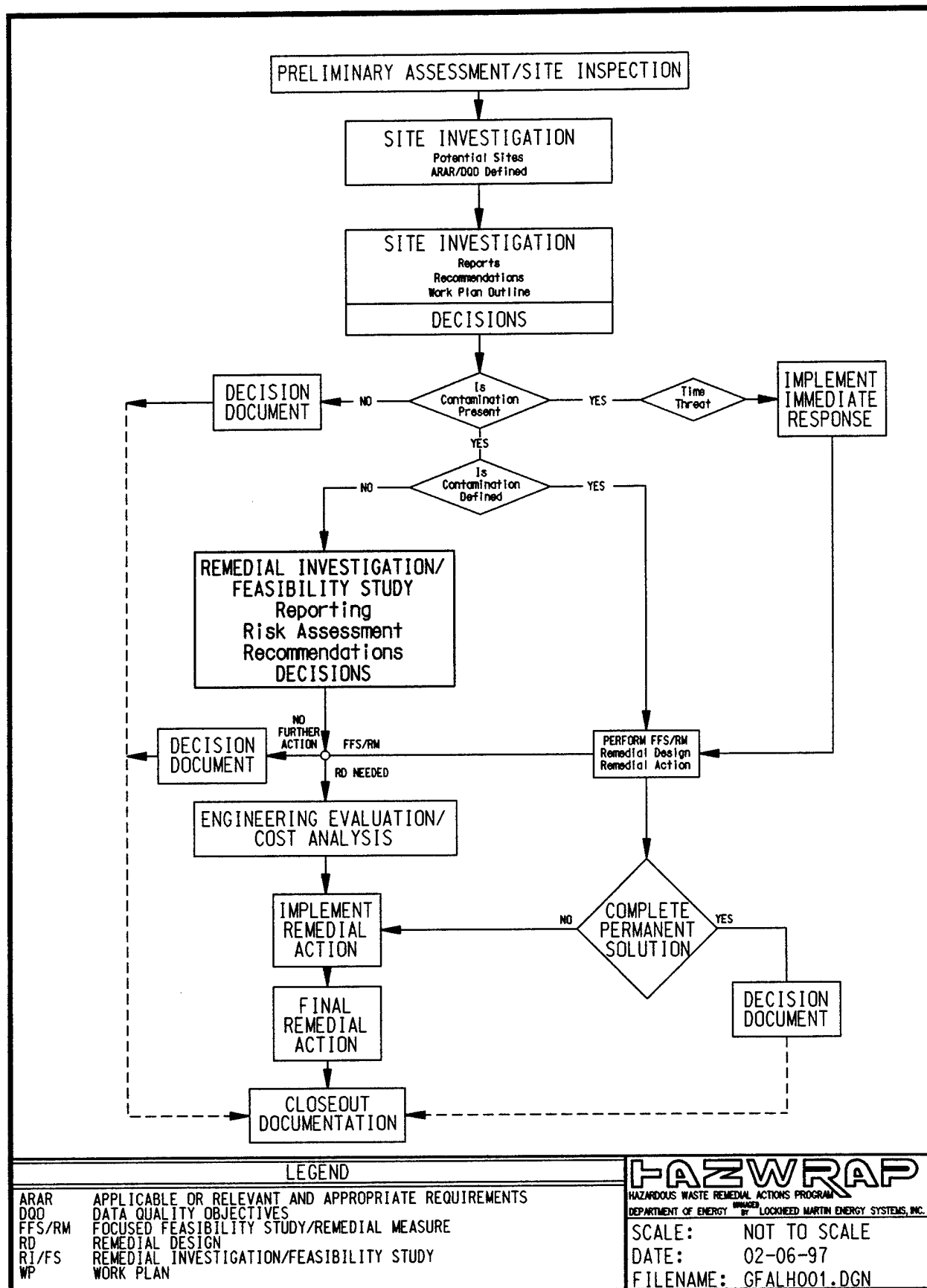


Fig. 1-1. Installation Restoration Program Flow Chart, 120 FW Montana Air National Guard, Great Falls, Montana



environmental media and evaluates the potential for contaminant migration through site-specific hydrogeologic determinations. The SI for Sites 1, 2, 3, 4, 5, 6, 7 and 8 was completed in February 1992 (Engineering Science 1992). Based on the results of the SI, Decision Documents (DDs) were prepared recommending no further action for soils and groundwater for sites 2,, 3, 4, and 5.

- **Remedial Investigation** An RI is conducted to acquire the necessary data to define the extent of confirmed environmental contamination and to assess further the associated potential risks to human health, welfare, and the environment. The RI quantifies the magnitude and extent of contamination at the sites under investigation and identifies the specific chemical contaminants present and their concentrations in environmental media. A determination also is made as to the potential for contaminant migration by assessing site-specific hydrogeologic and contaminant characteristics. The RI for Sites 6, 7, and 8 was initiated and is the subject of this report. In addition, a second monitoring well was installed at Site 1 to verify the lack of groundwater impact.
- **Engineering Evaluation/Cost Analysis** The purpose of an Engineering Evaluation/Cost Analysis (EE/CA) is to identify removal action objectives and identify and evaluate the removal action alternatives that will achieve these objectives. The EE/CA also serves as the basis for the Action Memorandum; Action Memoranda provide a Record of Decision process leading up to a removal action and must substantiate the need for a removal action. As part of the EE/CA the removal action alternatives are evaluated and compared with respect to effectiveness, implementability, and cost factors.
- **Feasibility Study** The objective of a Feasibility Study (FS) is to develop the remedial action alternative that mitigates confirmed environmental contamination at each site and meets the applicable or relevant and appropriate requirements (ARARs). The FS includes risk assessments and cost benefit analyses in providing the necessary data, direction, and documented supportive rationale to acquire regulatory concurrence (Federal, State, and local) with the recommended remedial alternative. The FS evaluates, develops, and provides recommendations for remedial actions at each site where remediation is required.
- **Remedial Design** The Remedial Design (RD) phase provides engineering design drawings and construction specifications required to implement the recommended remedial action selected through the FS process. Implementation of the remediation plan requires appropriate regulatory acceptance.
- **Remedial Action** The Remedial Action (RA) is the implementation of an RD. An RA plan requires appropriate regulatory acceptance before implementation. A removal action was performed on the soils at Site 1 in 1994. By a letter dated May 30, 1995, the Montana Department of Environmental Quality (MDEQ) determined that no further action was required to close Site 1.

## 1.2 PURPOSE OF THE REMEDIAL INVESTIGATION

This report documents the results of the field investigations conducted at IRP Sites 6, 7, and 8 in April, May, and July 1996. While in the field, additional work was done to complete SI

activities at Site 1. The work is included in the report. The primary objectives of the RI at IRP Sites 6, 7, and 8 were (1) to complete the characterization of the nature and extent of confirmed contamination, and (2) to complete the evaluation of human health and ecological risk assessments. Completion of these objectives enabled support of one or more of the following decisions for each site or site area(s):

- Preparation of an EE/CA to identify removal action objectives and evaluate removal alternatives.
- Preparation of an FS or Focused Feasibility Study (FFS) for evaluation of potential remedial measures.
- Recommendation of interim remedial measures.
- Preparation of Decision Documents (DDs) to support no further investigative actions.

### 1.3 REPORT ORGANIZATION

This RI report contains the following sections:

1. **Introduction** This section presents the introduction, which includes the purpose of the RI and RI report organization.
2. **Facility Background** This section presents the general facility background, site descriptions of IRP Sites 6, 7, and 8 and summaries of previous investigations and findings.
3. **Environmental Setting** This section presents the regional and local environmental settings including physiography and topography, climate, surface water hydrology, geology, hydrogeology, water resources, and ecology.
4. **Field Program** This section describes the activities, methods, and procedures used for characterizing the nature and extent of environmental contamination and the geologic/hydrogeologic conditions at IRP Sites 6, 7, and 8 (including background and site area sampling) and the disposal of investigation-derived wastes. Significant changes from proposed Work Plan activities and the fieldwork performed are also discussed.
5. **Investigation Findings** This section provides the geologic/hydrogeologic finds and field and laboratory analytical results obtained during the RI program and the significance of the results.
6. **Applicable or Relevant and Appropriate Requirements** This section presents Federal and State ARARs and includes discussions of regulatory contaminant levels and respective response criteria with respect to chemical laboratory analytical results.
7. **Contaminant Fate and Transport** This section provides an evaluation of possible fate and transport scenarios for site-related contaminants. Potential routes of migration and physical characteristics of chemicals of concern are considered in this evaluation.

8. **Baseline Risk Assessment** This section presents a screening level risk assessment intended to identify contaminants in each affected medium that could be associated with potential adverse effects to exposed human or ecological receptors. Preliminary Risk Evaluations are used to determine which sites, if any, should be investigated further or require no further action.
9. **Conclusions** This section presents site-specific conclusions based on the investigation and risk assessment findings.
10. **Recommendations** This section presents recommendations for any future IRP activities.
11. **References** This section provides the references noted in the report.

## 2. FACILITY BACKGROUND

### 2.1 FACILITY HISTORY

The Montana Air National Guard Base (ANGB) is located at the Great Falls International Airport in Cascade County, 3 miles southwest of the City of Great Falls, which is located in west central Montana as shown on Fig. 2.1. The Base consists of more than 50 buildings and occupies approximately 138 acres of land leased from the airport authority on the southeast corner of the 1,762-acre airport.

The Base is located on the Sun River bench, a topographic plateau situated about 350 feet (ft) above the surrounding plains. It is bordered on the west by agricultural land and to the north and northeast of the bench by residential areas. The area south of the Base is designated industrial and commercial; an open area to the southwest of the installation is used for outdoor recreation.

The 120th FW is an air defense unit with 15 primary assigned aircraft. Current assigned fighter interceptor aircraft are F16A and B models. Independent of the master plan, the 120th FW may be converted to a general purpose fighter mission with air-to-ground munitions capabilities. Overall, the 120th is tasked to serve the USAF and the DOD with a defense fighter group that can be mobilized in time of war or national emergency. In addition, the 120th FW ensures air sovereignty in its assigned air defense sectors and provides aircraft to intercept airborne objects posing a threat to the United States as part of the overall defense system of the North American continent.

The major support operations performed at the Base that use and dispose of hazardous wastes/hazardous materials include aircraft maintenance; ground maintenance; petroleum, oil, and lubricants (POL) management; and facilities maintenance. These activities generate varying quantities of waste oil, recovered fuels, spent cleaners, solvents, and acids.

The Base was first used as a military base, called Gore Field, before World War II when it headquartered the Army Air Corps 7th Ferry Group. The 7th Ferry Group airlifted equipment and supplies to the Soviet Union. The USAF and the ANG were formed after the end of World War II.

The present 120th FW began in 1947 as the 186th Fighter Squadron and was equipped with the P-51 "Mustang" aircraft, later designated the F-51. The 186th was mobilized for the Korean conflict with the F-51 reformed at the Great Falls International Airport in 1952 and became the first ANG unit in the United States to be assigned the F-86A aircraft in 1953. The Base was expanded in 1954 with the construction of six new buildings. The unit converted to the F-89C aircraft in 1955.

In 1956, the 186th Fighter Squadron was redesignated by the USAF as the 120th Fighter Group (FG). The aircraft were updated to the F-89H in 1959 and again in 1960 to the F-89J, which required runway extension. From 1965 to 1972, the Base used the F-102A aircraft. It converted to the F-106A aircraft in 1972.

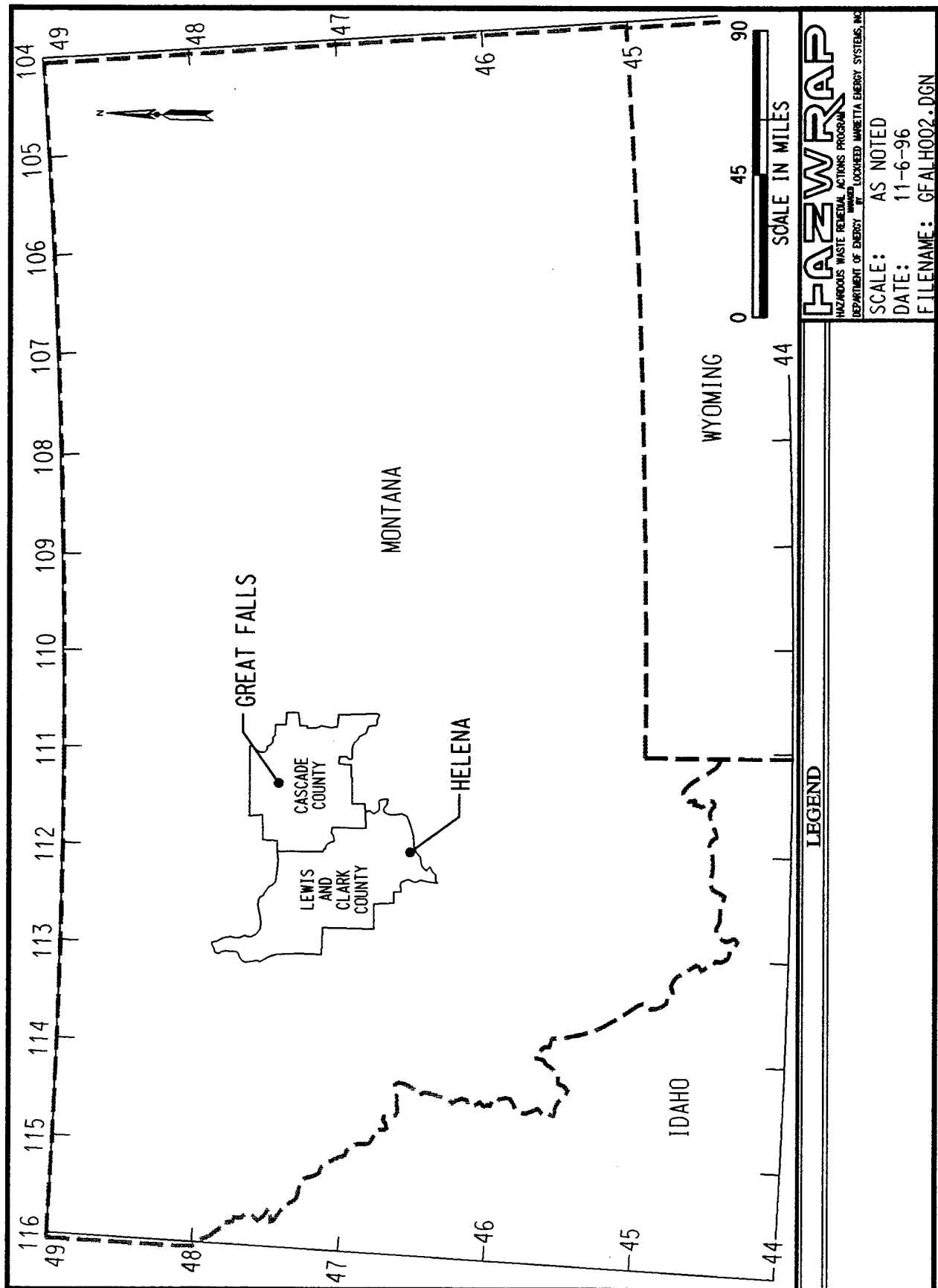


Fig. 2.1. Regional Location Map 120 FW Montana Air National Guard, Great Falls, Montana.

The 120th FW's mission was expanded in 1984 when it was assigned the additional task of operating an Alert Detachment at Davis-Monthan Air Force Base in Tucson, Arizona. Since 1987, the unit has flown the F-16 "Fighting Falcon."

## **2.2 PREVIOUS INSTALLATION RESTORATION PROGRAM ACTIVITIES**

### **2.2.1 Preliminary Assessment**

The IRP was initiated at the installation with a PA conducted in April 1988 by Dynamac Corporation under an HMTC contract. The results were summarized in a PA report (HMTC 1988). The PA consisted of an on-site visit that included interviews with past and present employees; the gathering and analysis of pertinent information and records of the Base's hazardous materials use; generation and disposal practices; and the analysis of available geologic, hydrologic, meteorologic, and environmental data from Federal, State, and local agencies.

The PA identified eight areas of concern at the installation where sufficient justification existed to collect environmental data to confirm or deny potential contamination of soil or groundwater by hazardous materials/hazardous wastes from Base activities. The eight sites selected for the IRP investigation are Site 1, Current Fire Training Area; Site 2, Former Fire Training Area; Site 3, North Disposal and Fire Training Pit; Site 4, Former Fire Training Area 1; Site 5, Former Fire Training Area 2; Site 6, Aerospace Ground Equipment (AGE) Area; Site 7, Dry Well Off Corrosion Control Building; and Site 8, Dry Well Off Composite Maintenance Building. The locations of these sites are shown on Fig. 2.2.

### **2.2.2 Site Investigation**

In 1989 an SI was initiated by the ANGB requiring investigation of the eight sites cited in the PA. The work was implemented in the field in 1990 by Engineering Science under a contract with HAZWRAP. The results of the investigation of the sites are presented in an SI report (Engineering Science 1992). Based on the results of the investigation, four of the eight sites (Sites 2, 3, 4, and 5) were recommended for DDs recommending no further action for both soil and groundwater. At Site 1, an FFS was recommended for soils; elevated concentrations of total petroleum hydrocarbons (TPH) were found in soils; because no risk evaluation criteria existed, remediation was recommended. Further, an additional monitoring well was recommended at Site 1 to ensure a representative downgradient sampling. An RI was recommended for the soils and groundwater at Sites 6, 7, and 8. Additional information regarding contamination found at these sites by the SI is included in Sect. 2.3 and in the SI report. The RI was recommended at the three sites because contamination found exceeded the preliminary risk evaluation (PRE) criteria for groundwater and to evaluate the potential for contaminated soils to continue to provide a source for contamination of the groundwater.

### **2.2.3 Removal Actions**

For Site 1, a Source Removal Action Plan for soils and Action Memorandum were submitted to the State in February and July 1992, respectively. The Removal Action Plan using aboveground bioremediation of contaminated soil at Site 1 (Current Fire Training Area) was implemented from April through October 1994. In February 1995, the Removal Action Plan

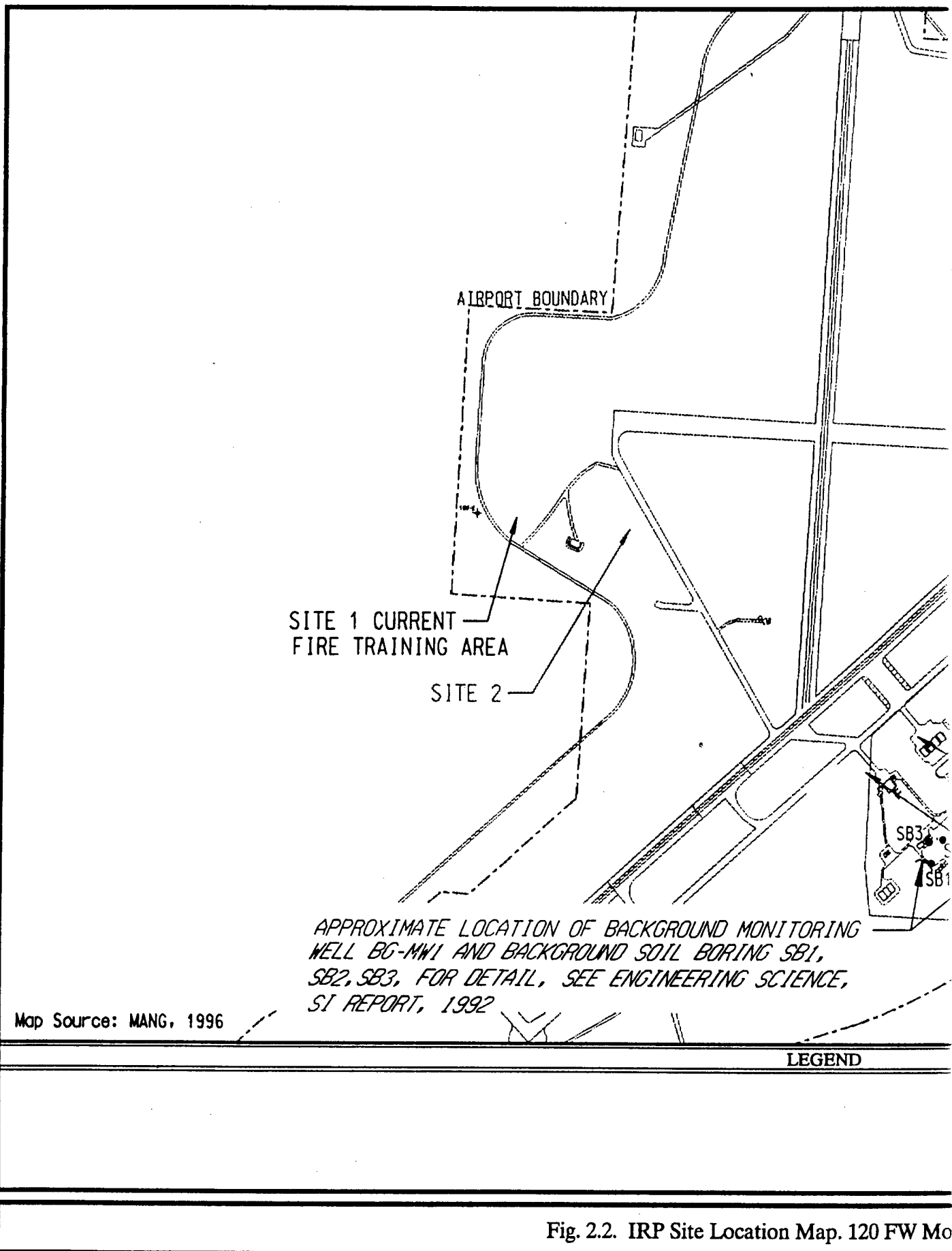
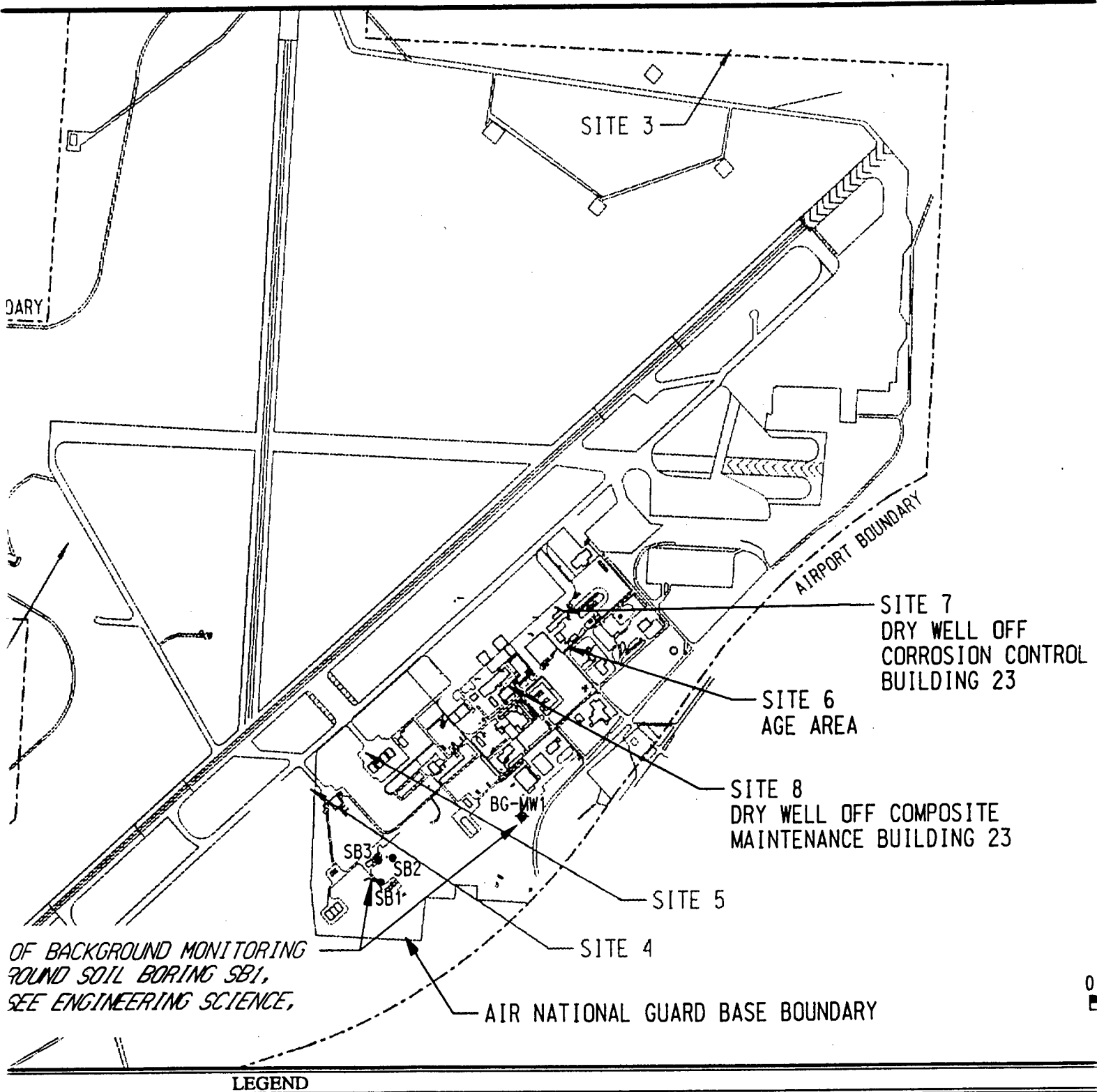
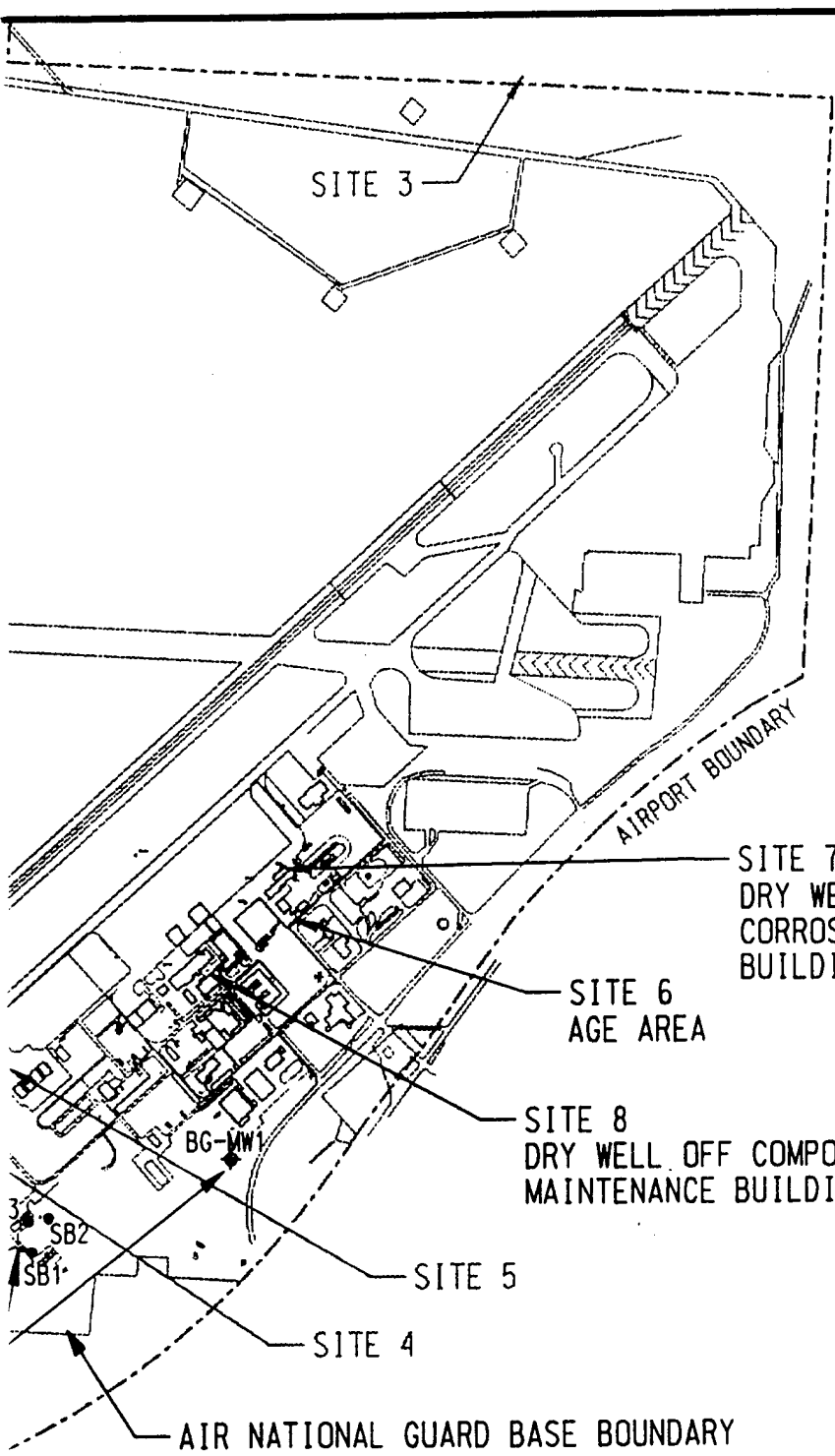


Fig. 2.2. IRP Site Location Map. 120 FW Mo



g. 2.2. IRP Site Location Map. 120 FW Montana Air National Guard, Great Falls Montana.





<b>HAZWRAP</b>	
HAZARDOUS WASTE REMEDIAL ACTIONS PROGRAM	
DEPARTMENT OF ENERGY <small>UNITED STATES OF AMERICA</small> LOCKHEED MARTIN ENERGY SYSTEMS, INC.	
SCALE:	1" = 1200' - 0"
DATE:	10-09-96
FILENAME:	GFALH003.DGN

3

Summary Report (AGI 1995) was issued; on May 30, 1995, in a letter entitled "Closure of Site No. 1, the Current Fire Training Area at the Great Falls International Airport," the MDEQ determined that no further action was required to close Site 1 noting that the site met all MDEQ criteria for existing and proposed site uses and the site posed no significant risk to public health, safety, or welfare (MDHES 1995).

As mentioned above, groundwater analytical results were inconclusive because of questions concerning whether a monitoring well was located downgradient of the impacted soil area.

## **2.3 SITE DESCRIPTIONS**

### **2.3.1 Site 1 - Current Fire Training Area**

Site 1 is located on the west side of the airport facility west of the power check pad and the small arms range and consists of one large and three small Fire Training Areas (FTAs); see Fig. 2.3. The site was used for fire training exercises from 1968 until early in 1989. It was reported from the PA that as much as 30,000 gal of fuel and other flammable liquids may have seeped into the soil at this site (HMTTC 1988).

Soil analytical results from the SI indicated high concentrations of several volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs) and metals above background concentrations in borings in and directly adjacent to the burn areas; none were above PRE values (Engineering Science 1992). High concentrations of TPH were found in a boring placed in the center of one of the burn areas. Soil samples outside the burn areas did not indicate the presence of elevated concentrations, thus suggesting the impacted area did not extend outside the burn areas. Groundwater analyses were inconclusive as detections found appeared to possibly be laboratory contaminants; chloroform was the only VOC detected in the first round and bis(2-ethylhexyl)phthalate was the only SVOC (detected in both rounds). Metals (barium, lead, selenium, zinc, and nickel) were also detected, but below the then-current 1992 ARARs. Uncertainty also existed as to whether the location of the monitoring well was definitely downgradient from the source areas.

A source removal action on the soils by aboveground bioremediation was carried out at the site in 1994 and closure for the site was effected in 1995. However, because of the uncertainty of the downgradient position of the sole monitoring well, another downgradient well was recommended to be installed and sampled as part of the RI activities.

### **2.3.2 Site 6 - Aerospace Ground Equipment Area (Building 22)**

At Site 6, from 1962 to 1978 approximately 17,000 gal of POL waste, hydraulic fluids, and solvents were reportedly discharged to a dry well believed to be located adjacent to the southwest side of Building 22 (see Fig. 2.4). The dry well was reported as being 3 ft in diameter and brick lined and was paved over in 1978. In addition, small amounts of waste oil were reportedly discharged to a ditch located southeast of Building 22 during the same time period.

A total of 14 soil borings (6SB-1 through 6SB-15) were drilled and sampled at Site 6: six in the area of the original site and eight additional borings in the area behind Building 22 and in between Buildings 21 and 23/24 (see Fig. 2.4). The analytical results indicate high concentrations

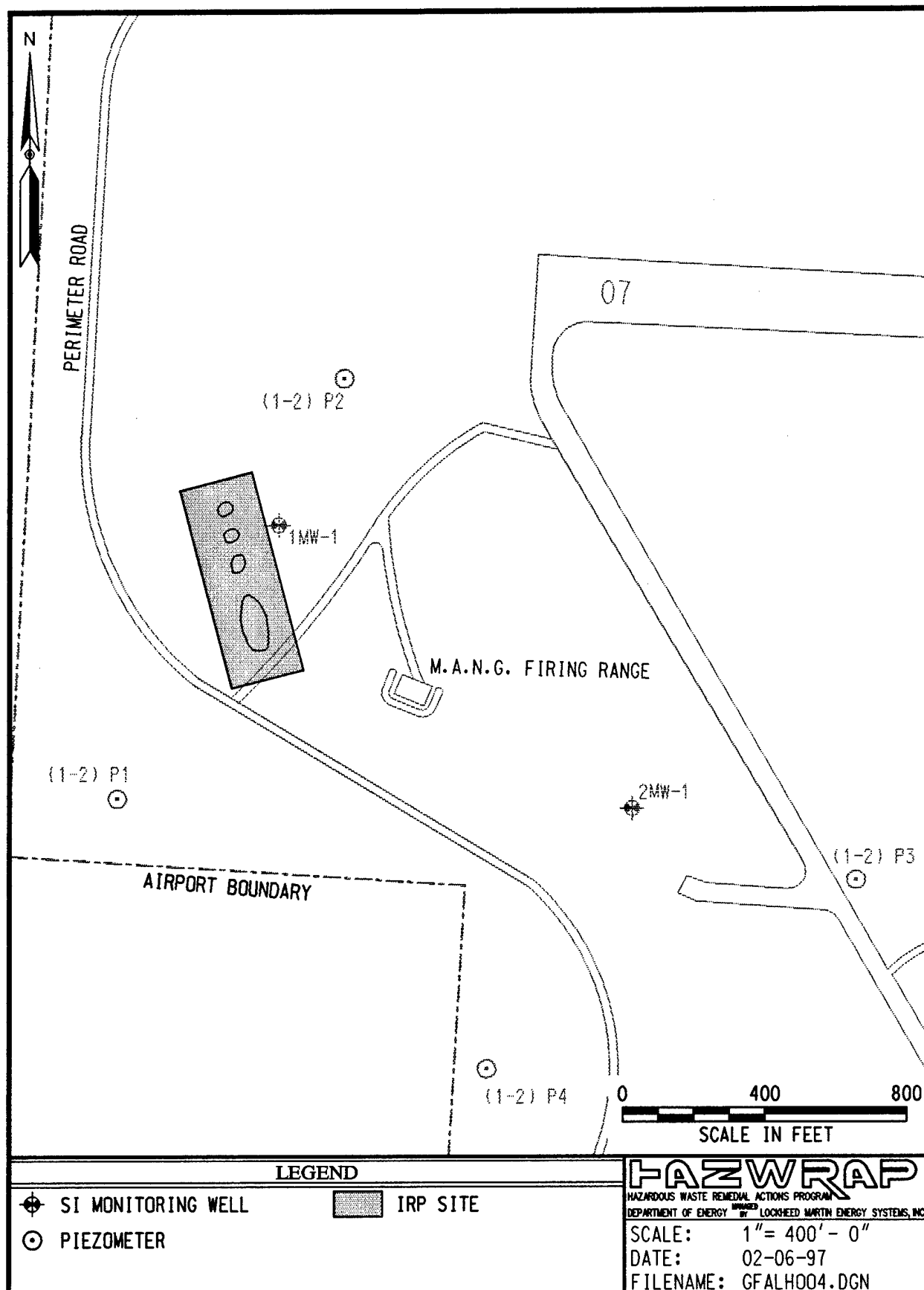
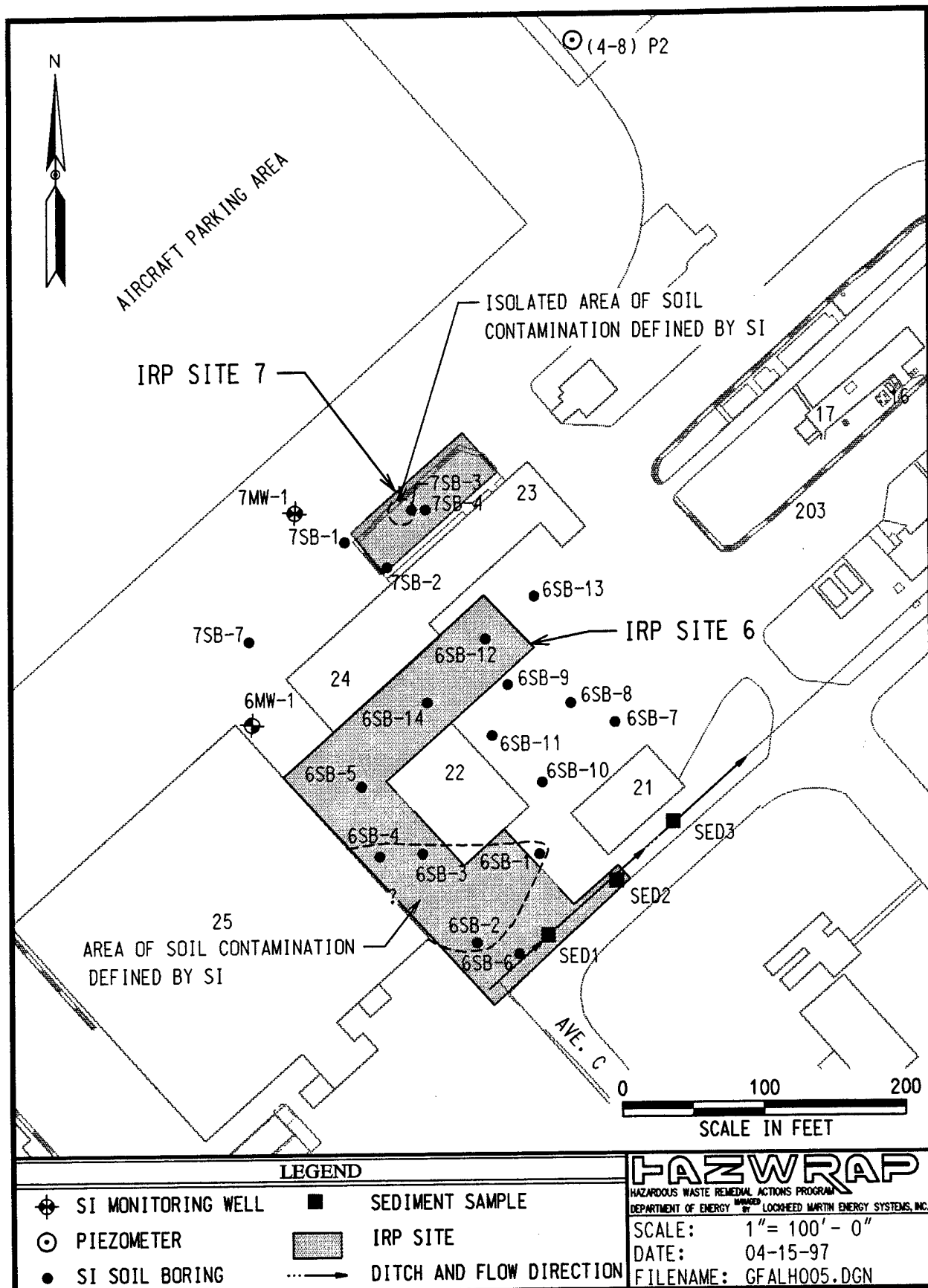


Fig. 2.3. IRP Site 1, SI Sampling Locations. 120th FW Montana Air National Guard, Great Falls, Montana.



for select VOCs, SVOCs, and TPH in soil borings near the reported location of the dry well. The results of the soil analytical data from the SI are presented in Tables 2.1 and 2.2. Exclusive of the suspected laboratory contaminants acetone and bis(2-ethylhexyl)phthalate, relatively high levels of fuel-related SVOCs (naphthalene and 2-methylnaphthalene) and fuel-associated VOC compounds (toluene, ethylbenzene and total xylenes) were detected in the two borings (SB3 and SB4) closest to the presumed dry well location. TCE at an estimated concentration of 4000 micrograms per kilogram ( $\mu\text{g}/\text{kg}$ ) was detected in SB3 at the 5.5-ft level. Metals detected above background in the soil were lead and cadmium. TPH analysis indicated some contamination at the site. No SVOCs, low levels of the common laboratory contaminant acetone, and one low-level detection of toluene were detected in the other eight soil borings. TPH concentrations ranged from nondetect to a high of 13,000 milligram per kilogram ( $\text{mg}/\text{kg}$ ). All metals for which analysis was performed (except copper) were detected at concentrations less than background plus two standard deviations.

Three sediment samples (SED1 through SED3) were collected from a drainage ditch along the southeast edge of the sits (see Fig. 2.4). The volatile samples were homogenized during collection and the data are considered invalid. No SVOCs were detected. These data, along with the data for metals, are presented in Table 2.3.

Ground-penetrating radar (GPR) was used to determine the location of the dry well; discussion presented in the SI indicates the presence of a reinforced concrete slab near the reported location of the dry well. Base personnel removed the asphalt from the concrete slab and uncovered the top of what was reported to be a brick-lined dry well extending to a depth of about 4 ft. A fluid sample and sludge was collected and turned over to the Base for analysis.

Analysis from groundwater samples from the single monitoring well, 6MW-1, at Site 6 indicated low, but above the then-current 1992 ARARs, concentrations of benzene [5.9/6.8 micrograms/liter ( $\mu\text{g}/\text{L}$ )], ethylbenzene, phthalates (which were attributed to laboratory contamination), and several metals at concentrations above background (Table 2.4).

### 2.3.3 Site 7 - Dry Well Off Corrosion Control Building (Building 23)

From 1955 to 1964, approximately 9400 gal of motor pool waste oils and fuels were disposed of via an underground pipe to a dry well located within 10 ft of the northwest wall of Building 23 (see Fig. 2.4.) The dry well is presently covered by grass and a flower bed. Base personnel, however, have indicated that the dry well may have been removed, and a GPR survey at the area indicates an area of subsurface soil disturbance at the presumed location.

Of the four soil borings, 7SB-1 through 7SB-4, drilled and sampled at Site 7 during the SI (see Fig. 2.4), one boring, 7SB-3, closest to the reported dry well had high concentrations of VOCs and SVOCs. These data are presented in Table 2.5. The compounds found are those commonly associated with fuels: benzene (up to 2,600  $\mu\text{g}/\text{kg}$ ), toluene (up to 140,000  $\mu\text{g}/\text{kg}$ ), ethylbenzene (up to 24,000  $\mu\text{g}/\text{kg}$ ), xylenes (up to 159,000  $\mu\text{g}/\text{kg}$ ), naphthalene (up to 22,000  $\mu\text{g}/\text{kg}$ ), and 2-methylnaphthalene (up to 42,000  $\mu\text{g}/\text{kg}$ ). TPH in the boring reached a concentration of 19,000  $\text{mg}/\text{kg}$ . Concentrations are significantly lower in the other soil borings, which indicates the soil contamination is apparently limited to the area near the reported dry well.

Table 2.1 Chemical Constituents Detected in Soil - Site Investigation, 1992  
Site 6: Aerospace Ground Equipment (AGE, Bldg. 22) Area  
(CLP Laboratory Analysis)

Chemical	Background (1)	MANG-6 SBI-1.5	MANG-6 SBI-3.5	MANG-6 SB2-1.5	MANG-6 SB2-7	MANG-6 SB3-5.5	MANG-6 SB4-5	MANG-6 SB5-3.5	MANG-6 SB6-3.5	Health (2) Criteria
<b>Volatile organics (<math>\mu\text{g}/\text{kg}</math>):</b>										
Acetone	ND-157	520 D	570 D	ND	99 J	ND	ND	ND	ND	8E06
Trichlorethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.4E04
Toluene	ND-9	4 J	5 J	ND	ND	17,000 J	4,000 J	ND	ND	1.6E07
Ethylbenzene	ND	ND	ND	ND	ND	1,600 J	770 J	ND	ND	8E06
m/p-Xylene (3)	ND	ND	ND	ND	ND	7,900 J	4,200 J	ND	ND	1.6E08
o-Xylene	ND	ND	ND	ND	ND	2,600 J	2,300 J	ND	ND	1.6E08
<b>BNA organics (<math>\mu\text{g}/\text{kg}</math>)</b>										
Naphthalene	ND	ND	ND	ND	ND	3,000 J	2,100 J	ND	ND	3.2E05
2-Methylnaphthalene	ND	ND	ND	ND	ND	2,700 J	2,600 J	ND	ND	—
bis(2-Ethylhexyl)phthalate	ND	ND	ND	ND	130 J	ND	ND	ND	ND	5E04
<b>Metals (mg/kg)</b>										
Arsenic	1.9-9.9	6.2	4.5	4.4	3.4	3.2 B	2.6	2.2	2.1	80
Barium	ND-1,231	187	189	155	73	145	164	261	333	5,600
Cadmium	ND	ND	ND	ND	ND	0.41	ND	ND	ND	40
Chromium	8.7-22.7	12.2	10.4	12.3	7.7	18.3	8.1	9.5	11.5	8E04
Copper	3.3-19.7	18.5 *	14.4 *	12.3 *	4.2 B *	7.4	8.5	4.7 B	6.1	—
Lead	3.4-13.0	11.7	12.6	28.3	14.7	52.3 N	12 N	7.5 N	7.6 N	500
Nickel	3.6-17.6	10.4 *	ND	ND	ND	ND	11	ND	7.7 B	1,600
Selenium	ND-0.66	ND	ND	ND	ND	ND	ND	ND	ND	240
Zinc	21.6-61.3	51.1	38.5	36.8	10.1	33.7 *	35.8 *	17.7 *	15.6 *	1.6E04
<b>Total petroleum hydrocarbons (mg/kg)</b>	ND	12	ND	120	ND	3,300	8,100	12	52	—

(1) Background is the average background concentration  $\pm$  two standard deviations.

(2) Based upon soil ingestion, see Sect. 4.

(3) Meta- and para-xylene coelute and are not distinguishable by this method.

ND = not detected.

Data qualifiers follow the data. The qualifiers are:

Organics:

J The value reported is an estimated concentration. This is used when the compound is detected at an amount below the reporting limit. For samples MANG-6-5.3-5.5 and MANG-6-5B4-5 hold time was exceeded.

D The data are still usable but should be considered estimates.

D This flag identifies a compound whose reported analytical results are calculated from a greater dilution than the primary analysis.

Metals:

B Reported value is less than reporting limit but greater than the instrument detection limit.

Table 2.2 Chemical Constituents Detected in Alternate Soil Borings - Site Investigation, 1992  
Site 6: Aerospace Ground Equipment (AGE, Bldg. 22) Area

Chemical	Background (1)	MANG-6 SB7-1	MANG-6 SB7-1(D)	MANG-6 SB8-1.5	MANG-6 SB9-1	MANG-6 SB10-1.5	MANG-6 SB11-1.3	MANG-6 SB12-3.5	MANG-6 SB13-1	MANG-6 SB14-5.5	Health (2) Criteria
Volatile organics (µg/kg)											
Acetone	ND-157	ND	ND	ND	170	ND	100	200	180	66 J	8E06
Toluene	ND-9	ND	ND	ND	ND	ND	ND	ND	7	ND	1.6E07
BNA organics (µg/kg)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---
Metals (mg/kg)											
Arsenic	1.9-9.9	5.9	4.5	3.6	7.2	3.8	3	4.3 S	4.8	2.4	80
Barium	ND-1,231	267	132	152	464	171	165	168	140	108	5,600
Cadmium	ND	ND	ND	ND	ND	ND	0.35 B	ND	ND	ND	40
Chromium	8.7-22.7	12.9 *	14.4 *	10.3 *	11.3 *	7.9 *	9.5 *	16.7 *	7.2 *	8.9 *	8E04
Copper	3.3-19.7	43.4	15.2	5.6	16.7	11.2	26.3	13.5	9.1	10	---
Lead	3.4-13.0	9.5	9.6	2.5 B	8.2	4.9 B	6.1	4.6 B	4.7 B	4.3 B	500
Nickel	3.6-17.6	ND	12.4	ND	7.3 B	ND	9	9.6	ND	ND	1,600
Selenium	ND-0.66	ND	ND	ND	ND	ND	0.37 BW	0.35 BW	ND	ND	240
Zinc	21.6-61.3	60.8	43.1	36.6	42.1	38.7	48.4	45.7	27.7	53.7	1.6E04
Total petroleum hydrocarbons (mg/kg)	ND	310	ND	170	650	130	13,000	16	60	ND	---

(1) Background range is the average  $\pm$  two standard deviations.

(2) Based upon soil ingestion, see Sect. 4.

ND= not detected.

Data qualifiers follow the data. The qualifiers are:

Organics:

J the value reported is an estimated concentration. This is used when the composed is detected at an amount below the reporting limit.

Metals:

B Reported value is less than reporting limit but greater than the instrument detection limit.

**Table 2.3 Chemical Constituents Detected in Sediment Samples - Site Investigation, 1992**  
**Site 6: Aerospace Ground Equipment (AGE, Bldg. 22) Area**  
**(CLP Laboratory Analysis)**

Chemical	Background (1)	MANG-6 SD1	MANG-6 SD2	MANG-6 SD2(D)	MANG-6 SD3	Health (2) Criteria
Volatile organics ( $\mu\text{g/kg}$ )	ND	ND R	ND R	ND R	ND R	—
BNA organics ( $\mu\text{g/kg}$ )	ND	ND	ND	ND	ND	—
Metals (mg/kg)						
Arsenic	1.9-9.9	6.3	4.9	5.9 S	5.3	80
Barium	ND-1,231	294	269	344	311	5,600
Cadmium	ND	5.4	6.4	6.0	5.9	40
Chromium	8.7-22.7	43.2 *	57.1 *	53.4 *	58.8 *	8E04
Copper	3.3-19.7	34.6	34.8	42.3	48.5	—
Lead	3.4-13.0	236	529	211	284	500
Mercury	ND	ND	0.061 B	0.06 B	0.061 B	24
Nickel	3.6-17.6	18.9	15.6	16.7	17.1	1,600
Selenium	ND-0.66	0.41 B	ND	ND	ND	240
Zinc	21.6-61.3	238	284	251	249	1.6E04
Total petroleum hydrocarbons (mg/kg)	ND	1,700	3,000	2,600	2,500	—

(1) Background range is the average  $\pm$  two standard deviations

ND= not detected.

Data qualifiers follow the data. The qualifiers are:

Organics

R These data are not considered valid.

Metals:

B Reported value is less than reporting limit but greater than the instrument detection limit.

S Reported value was determined by the method of standard additions.

\* Duplicate analysis not within control limits.



**Table 2.4 Chemical Constituents Detected in Groundwater - Site Investigation, 1992**  
**Site 6: Aerospace Ground Equipment (AGE, Bldg 22) Area**  
**(CLP Laboratory Analysis)**

Chemical	Round 1 MANG-6 MW1	Round 1 MANG-6 MW1-D	Round 2 MANG-6 MW1	Round 2 MANG-6 MW1-D	<u>Background</u>		ARARs (1)
					Round 1 MANG-BG MW1	Round 2 MANG-BG MW1	
GC volatile organics ( $\mu\text{g/L}$ )							
Benzene	1.8	1.8	6.8	5.9	ND	ND	5
Ethylbenzene	ND	ND	3.3	3.4	ND	ND	700
CLP semivolatile organics ( $\mu\text{g/L}$ )							
bis(2-Ethylhexyl)phthalate	6 J	21	ND	ND	ND	ND	4
Metals							
Arsenic	ND	1.5 JB	ND	ND	1.1 JB	ND	50
Barium	212 J	215 J	248	250	56 JB	62.2 B	1,000
Cadmium	ND	ND	2.7 B	ND	ND	ND	10
Copper	6 BJ	ND	ND	ND	ND	ND	1,300
Lead	6.3 J	3.8 J	4.2 JN	4.2 JN	4.9 J	4.3 JN	50
Mercury	0.19 B	ND	ND	ND	ND	ND	2
Zinc	52 J*	15 JB*	9.4 JB	ND	15 JB*	9.8 JB	5,000
Total petroleum hydrocarbons (mg/L)	ND	ND	ND	1	1	ND	NA

(1) ARARs are proposed only. These are MCLs where available, otherwise WQC.

NA = not applicable.

ND = not detected.

Data qualifiers follow the data. The qualifiers are:

Organics:

J The value reported is an estimated concentration. This is used when the compound is detected at an amount below the reporting limit.

Metals:

B Reported value is less than reporting limit but greater than the instrument detection limit.

N Spiked sample recovery not within control limits set by laboratory QA/QC.

\* Duplicate analysis not within control limits set by laboratory QA/QC.

J The value reported is an estimated concentration. This is used when the compound is detected at less than 10 times the amount in an associated preparation blank or less than 5 times the amount in an associated field blank.

Table 2.5 Chemical Constituents Detected in Soil - Site Investigation, 1992  
Site 7: Dry Well Off Corrosion Control Building  
(CLP Laboratory Analysis)

Chemical	Background (1)	MANG-7 SB1-1.5	MANG-7 SB2-1	MANG-7 SB3-3.5	MANG-7 SB3-5.5	MANG-7 SB4-5	Health (2) Criteria
Volatile Organic ( $\mu\text{g/kg}$ ):							
Acetone	ND-157	ND	ND	ND	ND	J	8E06
Benzene	ND	ND	ND	2,600 J	ND	ND	2.4E04
Toluene	ND-9	ND	ND	76,000	140,000	ND	1.6E07
Ethylbenzene	ND	ND	ND	13,000	24,000	ND	8E06
m/p-Xylene (3)	ND	ND	ND	78,000	110,000	ND	1.6E08
o-Xylene	ND	ND	ND	41,000	49,000	ND	1.6E08
BNA organics ( $\mu\text{g/kg}$ )							
Naphthalene	ND	ND	ND	22,000	13,000	ND	3.2E05
2-Methylnaphthalene	ND	ND	ND	42,000	27,000	ND	—
Di-a-butylphthalate	ND	ND	ND	ND	ND	140 J	8E06
bis(2-Ethylhexyl)phthalate	ND	ND	ND	5,400	2,800 J	ND	5E04
Metals (mg/kg)							
Arsenic	1.9-9.9	2.7	4.5	4.6	5.8	6.2	80
Barium	ND-1,231	250	178	257	253	11	5,600
Chromium	8.7-22.7	9.7	16.5	15.7	12.3	7.9	8E04
Copper	3.3-19.7	19	15.3	17 *	17 *	17.1 *	—
Lead	3.4-13.0	8 N	10.7 N	443	167	9.9	500
Nickel	3.6-17.6	ND	10.1	10.5	7.8	ND	1,600
Selenium	ND-0.66	ND	ND	0.6 B	0.42 BW	0.37 B	240
Zinc	21.6-61.3	30.4 *	43.2 *	158 *	116 *	39.6 *	1.6E04
Total Petroleum hydrocarbons (mg/kg)	ND	34	17	19,000	14,000	44	—

(1) Background range is the average  $\pm$  two standard deviations.

(2) Based on soil ingestion, see Sect. 4.

(3) Meta- and para-xylene coelute and are not distinguishable by this method.

ND = not detected.

Data qualifiers follow the data. The qualifiers are:

Organics:

J The value reported is an estimated concentration. This is used when the compound is detected at an amount below the reporting limit.

Metals:

B Reported value is less than reporting limit but greater than the instrument detection limit.

N Spiked sample recovery not within control limits set by laboratory QA/QC.

\* Duplicate analysis not within control limits set by laboratory QA/QC.

Analysis of groundwater samples taken from the monitoring well, 7MW-1, at the site indicated one VOC above ARARs current in the 1992 SI Report and the presence of two other fuel-related VOCs. Benzene in the well was detected at a maximum of 11  $\mu\text{g/L}$ , and ethylbenzene and xylenes (total) were detected at concentrations of up to 160  $\mu\text{g/L}$  and 500  $\mu\text{g/L}$ , respectively (Table 2.6). The SVOCs detected were naphthalene (up to 24  $\mu\text{g/L}$ ), 2-methylnaphthalene (up to 11  $\mu\text{g/L}$ ) and 2,4-dimethylphenol (up to 2  $\mu\text{g/L}$ ). Several metals (arsenic, barium, lead, and zinc) were above background values.

#### **2.3.4 Site 8 - Dry Well Off Composite Maintenance Building (Building 32)**

From 1971 to 1977, small amounts of waste engine oil, hydraulic fluids, paint thinners and strippers, JP-4, and PD-680 may have been deposited in a dry well located between Buildings 30 and 32 at Site 8 (see Fig. 2.5). The dry well location currently is paved over by asphalt.

Results of a GPR survey conducted during the SI indicated an area of disturbed soil in the vicinity of the dry well location. From the size and character of the disturbed area on the GPR profiles it appears, however, the dry well has been removed and the location backfilled.

In general, soil borings drilled close to the former location of the dry well contained levels of fuels and solvent contamination above background (see Table 2.7). One boring, SB4, showed detections of trichloroethene at 260  $\mu\text{g/kg}$ , chlorobenzene at 35  $\mu\text{g/L}$ , and 1,2/1,4-dichlorobenzene at 180  $\mu\text{g/kg}$  and an estimated 240  $\mu\text{g/kg}$ . Other borings had low-level concentrations of organic fuel compounds and low concentrations of chlorinated solvents present. In addition to the VOC and SVOC contamination, TPH and three metals (arsenic, copper, and lead) were also found at levels above background. °

Groundwater contamination found in samples from the one monitoring well, 8MW-1, at Site 8 found two chlorinated solvents present above the then-current 1992 ARARs, trichloroethene (up to 18.4  $\mu\text{g/L}$ ) and 1,2-dichloroethene (160  $\mu\text{g/L}$ ). The one SVOC detected was bis(2-ethylhexyl)phthalate (see Table 2.8). Very low levels of TPH were also present, and three metals were found at concentrations above background.

**Table 2.6 Chemical Constituents Detected in Groundwater - Site Investigation, 1992**  
**Site 7: Dry Well Off Corrosion Control Building**  
**(CLP Laboratory Analysis)**

Chemical	Round 1 MANG-7 MW1	Round 2 MANG-7 MW1	Background		ARARs
			Round 1 MANG-BG MW1	Round 2 MANG-BG MW1	
GC volatile organics ( $\mu\text{g/L}$ )					
Benzene	11	4.1	ND	ND	5
Ethylbenzene	160	27.5	ND	ND	700
Xylenes (total)	500	240	ND	ND	10,000
CLP semivolatile organics ( $\mu\text{g/L}$ )					
Naphthalene	24	ND	ND	ND	—
2-Methylnaphthalene	11 J	ND	ND	ND	—
2,4-Dimethylphenol	ND	2 J	ND	ND	—
Metals ( $\mu\text{g/L}$ )					
Arsenic	1.5 JB	ND	1.1 JB	ND	50
Barium	95 JB	145 B	56 JB	62.2 B	1,000
Lead	4.7 J	4.3 JN	4.9 J	4.3 JN	50
Zinc	30 J*	14 JB	15 JB*	9.8 JB	5,000
Total petroleum hydrocarbons (mg/L)	ND	ND	1	ND	NA

NA = not applicable.

ND = not detected.

Data qualifiers follow the data. The qualifiers are:

Organics:

J The value reported is an estimated concentrations. This is used when the compound is detected at an amount below the reporting limit.

Metals:

B Reported value is less than reporting limit but greater than the instrument detection limit.

N Spiked sample recovery not within control limits set by laboratory QA/QC.

\* Duplicate analysis not within control limits set by laboratory QA/QC.

J The value reported is an estimated concentration. This is used when the compound is detected at less than 10 times the amount in a preparation blank or less than 5 times the amount in an associated field blank.

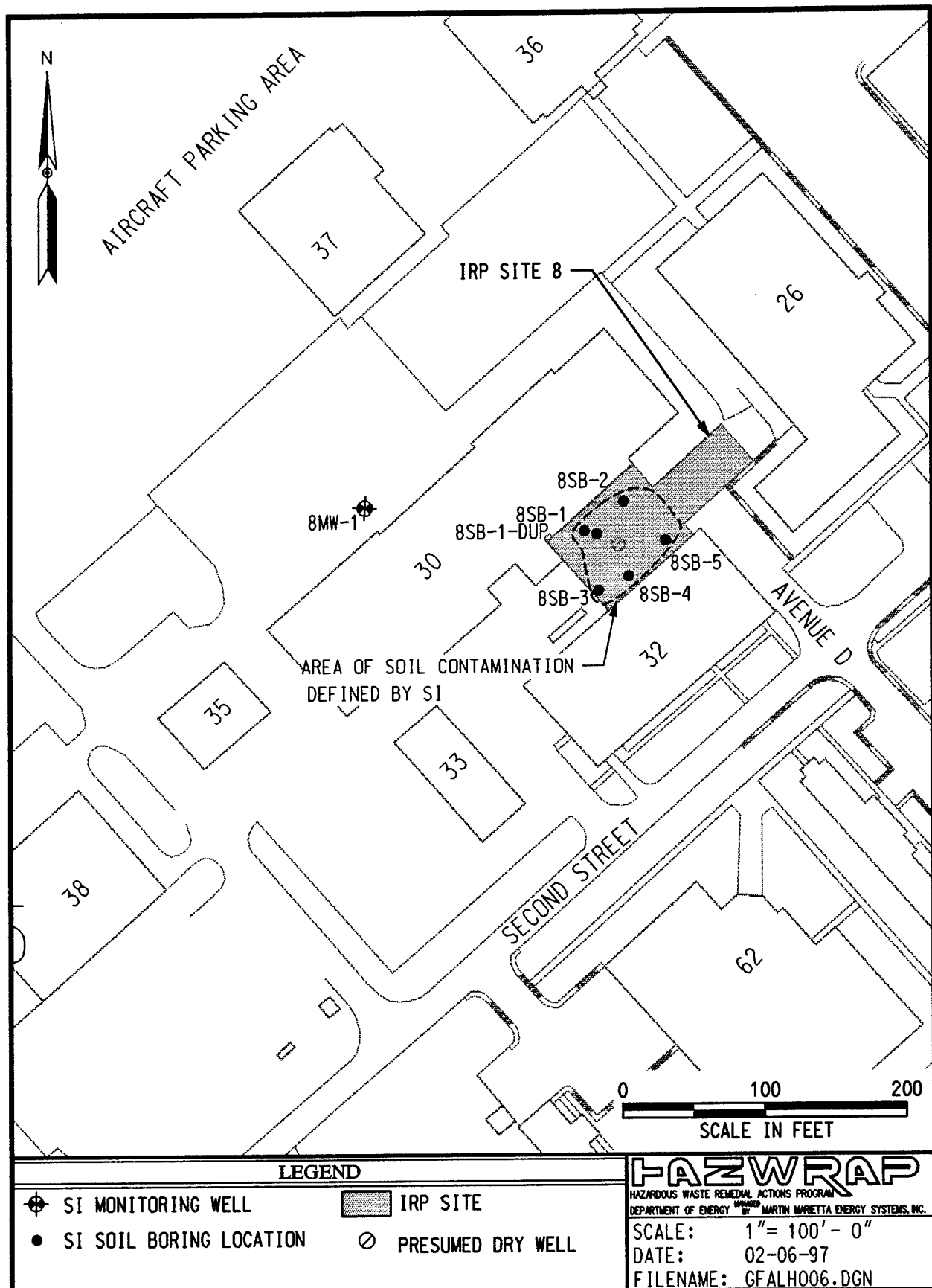


Fig. 2.5. IRP Site 8, SI Sampling Locations. 120 FW Montana Air National Guard, Great Falls, Montana.

**Table 2.7 Chemical Constituents Detected in Soil - Site Investigation, 1992**  
**Site 8: Dry Well Off Composite Maintenance Building (Bldg.32)**  
**(CLP Laboratory Analysis)**

Chemical	Background (I)	MANG-8 SB1-1.5	MANG-8 SB2-3	MANG-8 SB3-3	MANG-8 SB4-1.5	MANG-8 SB4-5.5	MANG-8 SB5-1	MANG-8 SB5-5.5	MANG-8 SB1-1.5	Health (2) Criteria
<b>Volatile organics (<math>\mu\text{g/kg}</math>):</b>										
Acetone	ND-157	95 J	140	ND	ND	120	ND	24 J	56 J	8E06
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	8	1.6E06
Trichloroethene	ND	ND	ND	4 J	260	ND	ND	ND	ND	6.4E04
Toluene	ND-9	29	ND	ND	6	ND	ND	ND	46	1.6E07
Chlorobenzene	ND	ND	ND	ND	35	ND	ND	ND	ND	1.6E06
Ethyl benzene	ND	ND	ND	ND	ND	ND	ND	ND	8	8E06
m/p-Xylene (3)	ND	11	ND	ND	ND	ND	ND	ND	14	1.6E08
o-Xylene	ND	10	ND	ND	ND	ND	ND	ND	9	1.6E08
1,2/1,4-Dichlorobenzene	ND	ND	ND	ND	180	ND	ND	ND	ND	2.4E04
<b>BNA organics (<math>\mu\text{g/kg}</math>):</b>										
1,2-Dichlorobenzene	ND	ND	ND	ND	240 J	ND	ND	ND	ND	7.2E06
<b>Metals (mg/kg):</b>										
Arsenic	1.9-9.9	6.3	7.1	22.2	7.4	3.2	3.2	3.5	7.3	80
Barium	ND-1,231	182	302	119	223	151	73.4	88.5	187	5,600
Chromium	8.7-22.7	9.4	12.5	10.5	14	15.6	8.9	12.6	14.6	8E04
Copper	3.3-19.7	12.6	17.2	6	19.8	7.4	5.2	6.3	14.2	—
Lead	3.4-13.0	11.4 N	13.7 N	12.3 N	14.9 N	7.5 N	7.4 N	8.9 N	12.9 N	500
Nickel	3.6-17.6	7.5 B	8.5	ND	ND	7.8	ND	ND	7.6 B	1,600
Selenium	ND-0.66	ND	ND	0.32 B	ND	0.35 B	ND	ND	ND	240
Zinc	21.6-61.3	39.2 *	46.3 *	20.2 *	48.3 *	37.7 *	26 *	42.9 *	45.4 *	1.6E04
<b>Total Petroleum hydrocarbons (mg/kg)</b>	ND	140	26	ND	ND	ND	ND	ND	22	—

(1) Background range is the average  $\pm$  two standard deviations.

(2) Based upon soil ingestion, see Sect. 4.

(3) Meta- and para-xylene coelute and are not distinguishable by this method.

ND = not detected

Data qualifiers follow the data. The qualifiers are:

VOA and BNA organics:

J The value reported is an estimated concentration. This is used when the compound is detected at an amount below the reporting limit.

Metals:

B Reported value is less than reporting limit but greater than the instrument detection limit.

N Spiked a sample recovery not within control limits set by laboratory QA/QC.

**Table 2.8 Chemical Constituents Detected in Groundwater - Site Investigation, 1992**  
**Site 8: Dry Well Off Composite Maintenance Building (Bldg. 32)**  
**(CLP Laboratory Analysis)**

Chemical	Round 1 MANG-8 MW1	Round 2 MANG-8 MW1	Background		ARARs (1)
			Round 1 MANG-BG MW1	Round 2 MANG-BG MW1	
GC volatile organics ( $\mu\text{g/L}$ ):					
Chloroform	ND	2.3 J	ND	ND	100
1,1-Dichloroethane	ND	5	ND	ND	
1,2-Dichloroethane	48.0	160	ND	ND	70
1,1,1-Trichloroethane	ND	6.1	ND	ND	
Tetrachloroethene	2.8	4.5	ND	ND	5
Trichloroethene	3.5	18.4	ND	ND	5
CLP semivolatile organics ( $\mu\text{g/L}$ ):					
bis(2-Ethylhexyl)phthalate	7 J	ND	ND	ND	4
Metals ( $\mu\text{g/L}$ ):					
Arsenic	ND	ND	1.1 JB	ND	50
Barium	70 JB	51.2 B	56 JB	62.2 B	1,000
Lead	5.8 J	4.3 JN	4.9 J	4.3 JN	50
Zinc	11 JB*	9.4 JB	15 JB*	9.8 JB	5,000
Total petroleum hydrocarbons (mg/L)	3	ND	1	ND	NA

(1) ARARs are proposed only. These are MCLs where available, otherwise WQC.

NA = not applicable

ND = not detected.

Data qualifiers follow the data. The qualifiers are:

Organics:

- J The value reported is an estimated concentration. This is used when the compound is detected at an amount below the reporting limit. For chloroform on sample MANG-8-MW1 (round 2), the compound was detected at less than 5 times the amount detected in an associated blank.

Metals:

- B Reported value is less than reporting limit but greater than the instrument detection limit.  
N Spiked sample recovery not within control limits set by laboratory QA/QC.  
\* Duplicate analysis not within control limits set by laboratory QA/QC.  
J The value reported is an estimated concentration. This is used when the compound is detected at less than 10 times the amount in an associated preparation blank or less than 5 times the amount in an associated field blank.

### 3. ENVIRONMENTAL SETTING

#### 3.1 PHYSIOGRAPHY

The City of Great Falls is located in Cascade County in west-central Montana, east of the Continental Divide, 91 miles northeast of Helena, and about 120 miles south of the Canadian border, as shown on Fig. 3.1. The Montana ANGB lies on the northeastern edge of the Sun River bench, a topographic feature situated about 350 ft above the confluence of the Sun and Missouri Rivers south and 3 miles southwest of Great Falls (see Fig. 3.2). The elevation of the installation is 3679 ft. The Sun River bench is a relatively flat plateau that slopes downward to the northwest at approximately 50 ft per mile. The area of the installation is located in the Great Plains Physiographic province east of the boundary of the Northern Rocky Mountains province and the Great Plains province (see Fig. 3.3). The Great Plains are generally flat with areas of negative relief such as the Missouri River valley and areas of positive relief such as the Highwood Mountains.

#### 3.2 METEOROLOGY

The average annual precipitation for Great Falls is 15.2 in. and classifies the area as semiarid. The calculated net precipitation value is approximately -19 in. About 70% of the annual total falls between April and September; the months of May and June normally have more than 2 in. of rain per month. The maximum rainfall based on a 24-hr period is 3.4 in. (May 1980) and the maximum monthly recorded is 8.13 in. (in May 1953). The mean annual temperature is 45.1°F, with winters averaging around 25°F and summers averaging about 66°F.

#### 3.3 GEOLOGY

##### 3.3.1 Regional Geology

The Great Falls Air National Guard Installation is located on the northeast edge of the Sun River bench, a plateau or cuesta of Cretaceous age rocks on the northwest flank of the Sweetgrass Arch; it rises about 350 ft above Great Falls and dips gently off toward the northwest. A surface geologic map of the Base and surrounding area is presented as Fig. 3.4 and indicates the location of a cross section, Fig. 3.5, showing the bench in relation to the valley floor of the Sun River and the relative positions of geologic units underlying the area.

The rock units underlying the installation consist of, in descending order, the Taft Hill and Flood Members of the Blackleaf Formation of the Colorado Group and the Kootenai Formation. Both the Blackleaf and Kootenai are Cretaceous in age. These are underlain in turn by the Morrison and Swift Formations of Jurassic age and the Madison Group of Mississippian age (see Fig. 3.6).

Erosional remnants of the Taft Hill Member outcrop at and around the installation and make up the majority of the unconsolidated and consolidated material found in the upper 15 to 20 ft underlying the Base. At the type locality for the Taft Hill located to the west of the Base, the



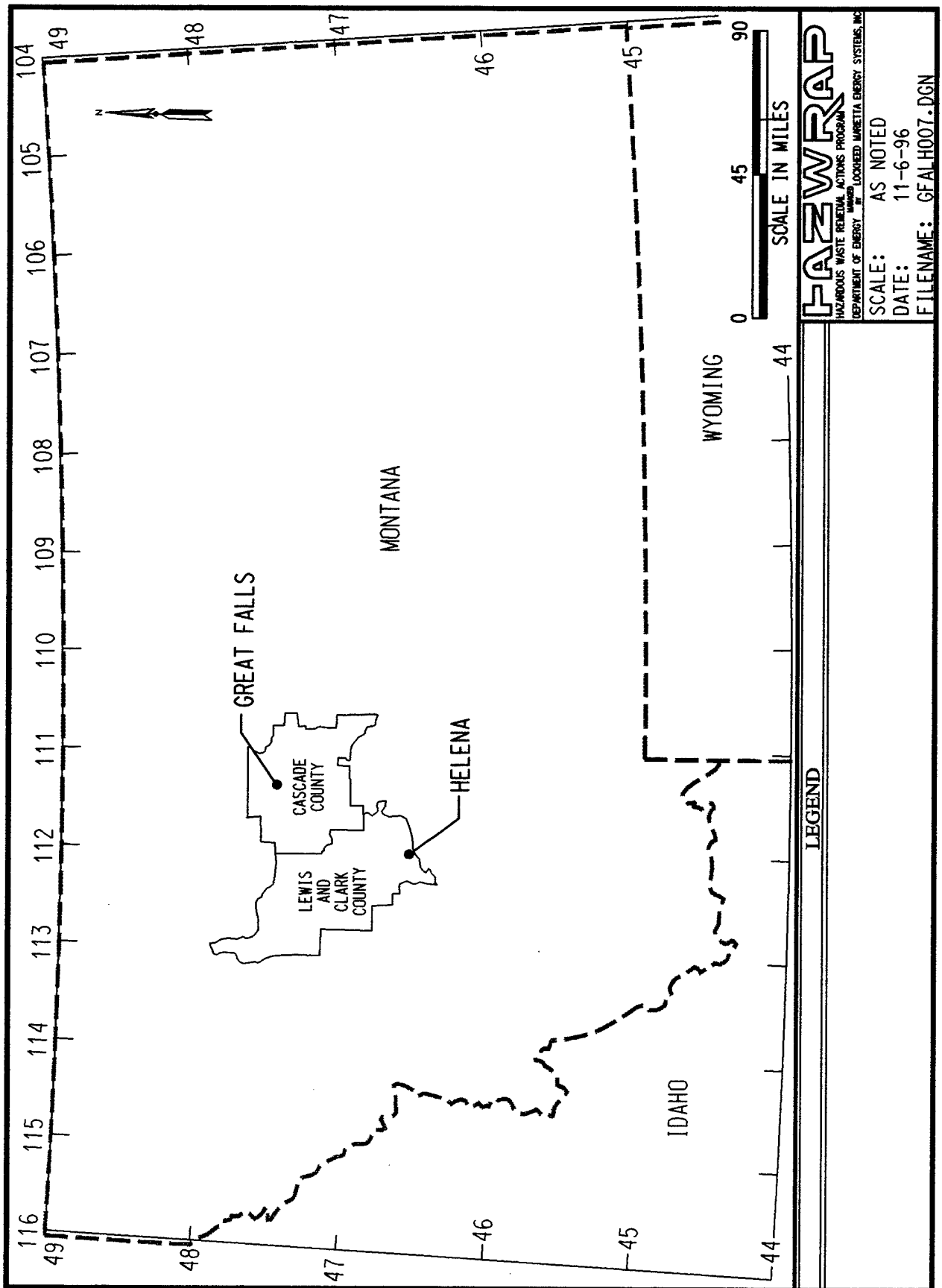


Fig 3.1. Regional Location Map 120 FW Montana Air National Guard, Great Falls, Montana.

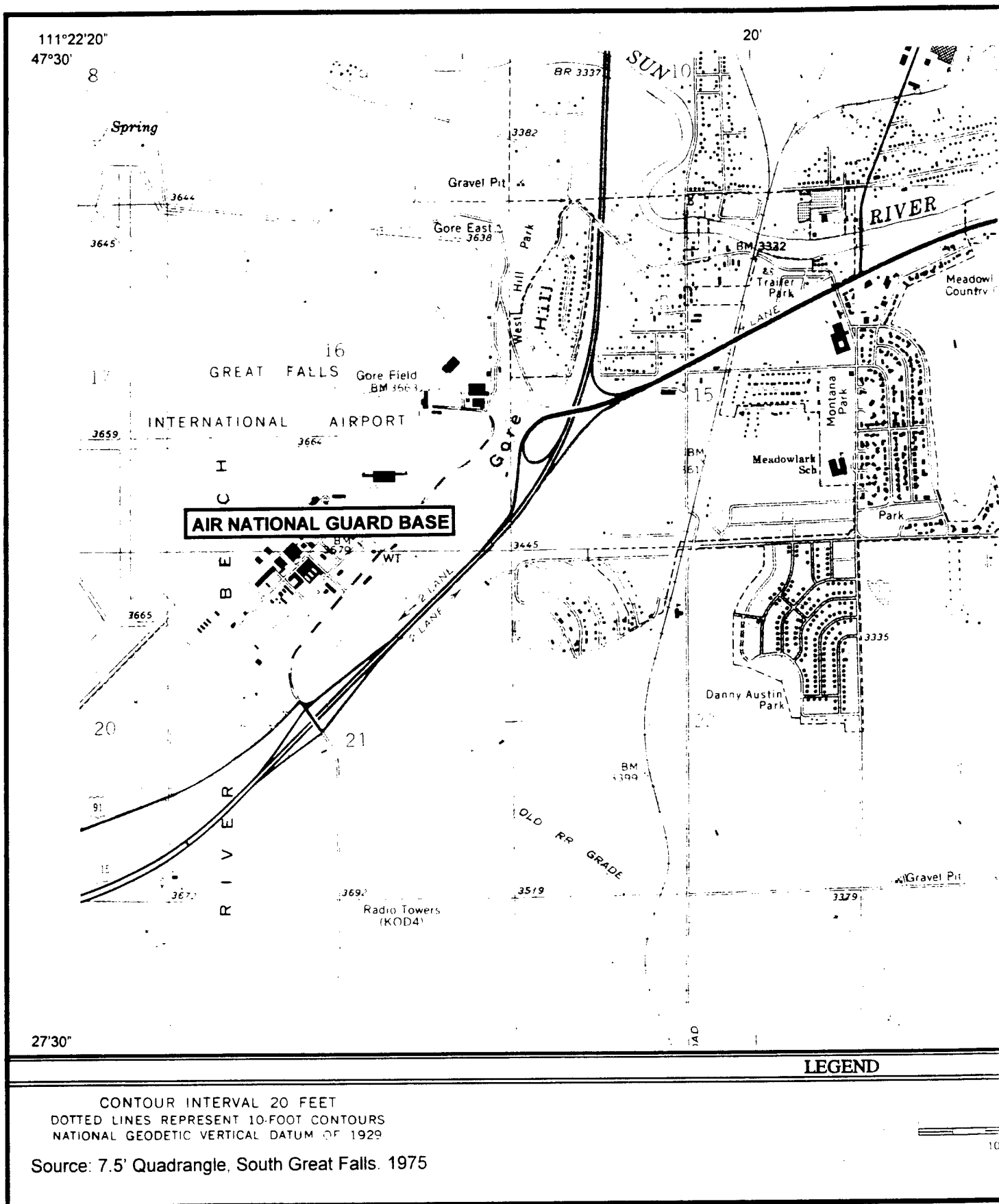
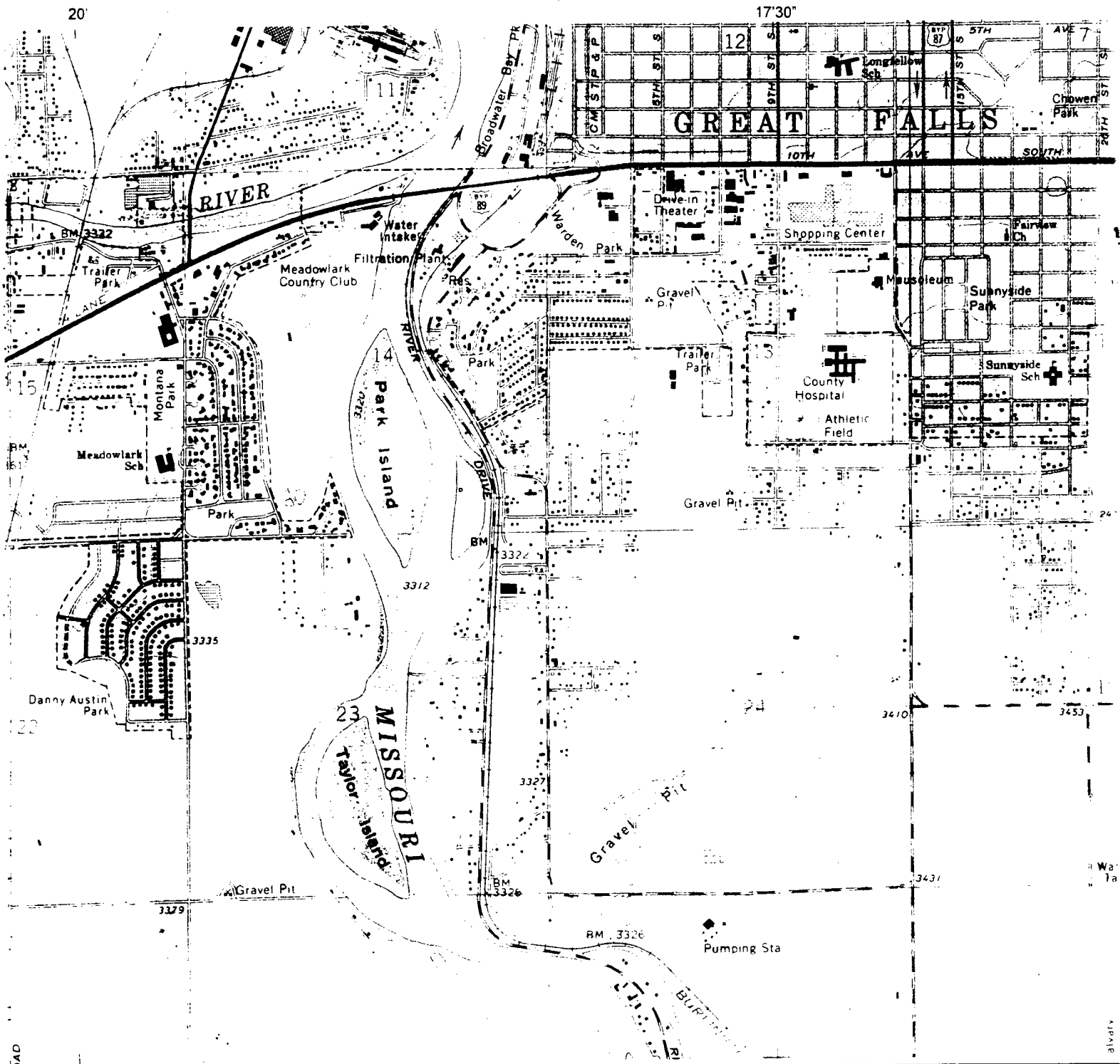
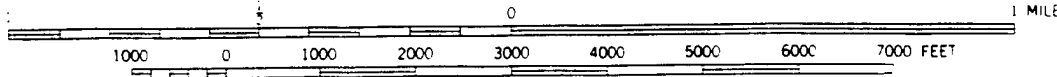


Fig. 3.2. Location Map, Montana Air National Guard Base. 1



# LEGEND

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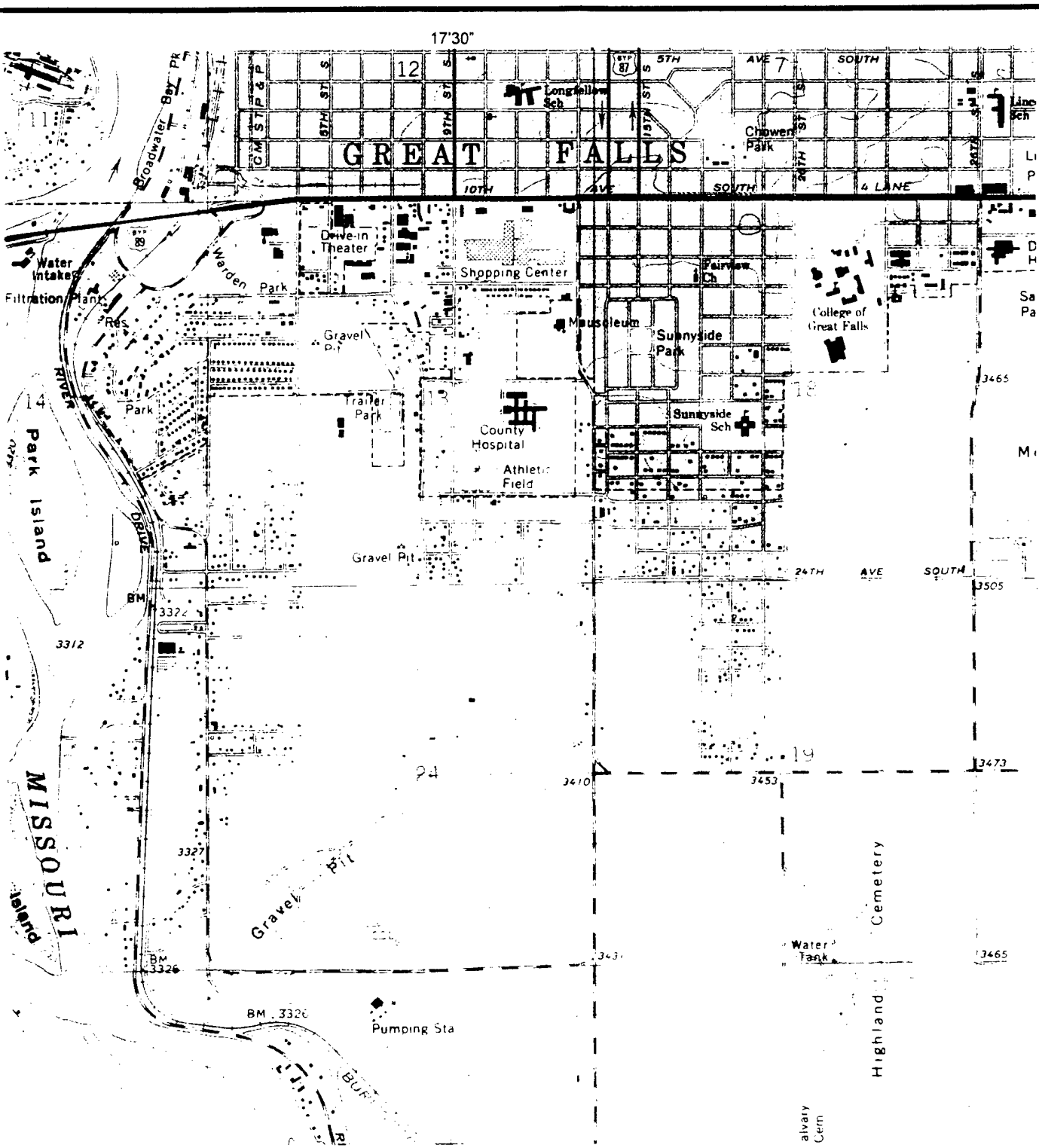


**FAE**  
HAZARDOUS WASTE  
DEPARTMENT OF ENVIRONMENT

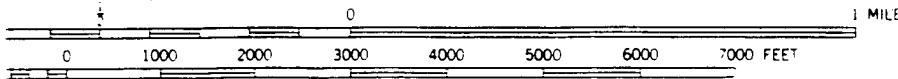
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HAZARDOUS WASTE REMEDIAL ACTIONS PROGRAM  
DEPARTMENT OF ENERGY  LOCKHEED MARTIN ENERGY SYSTEMS, INC.

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FW Montana Air National Guard, Great Falls Montana.

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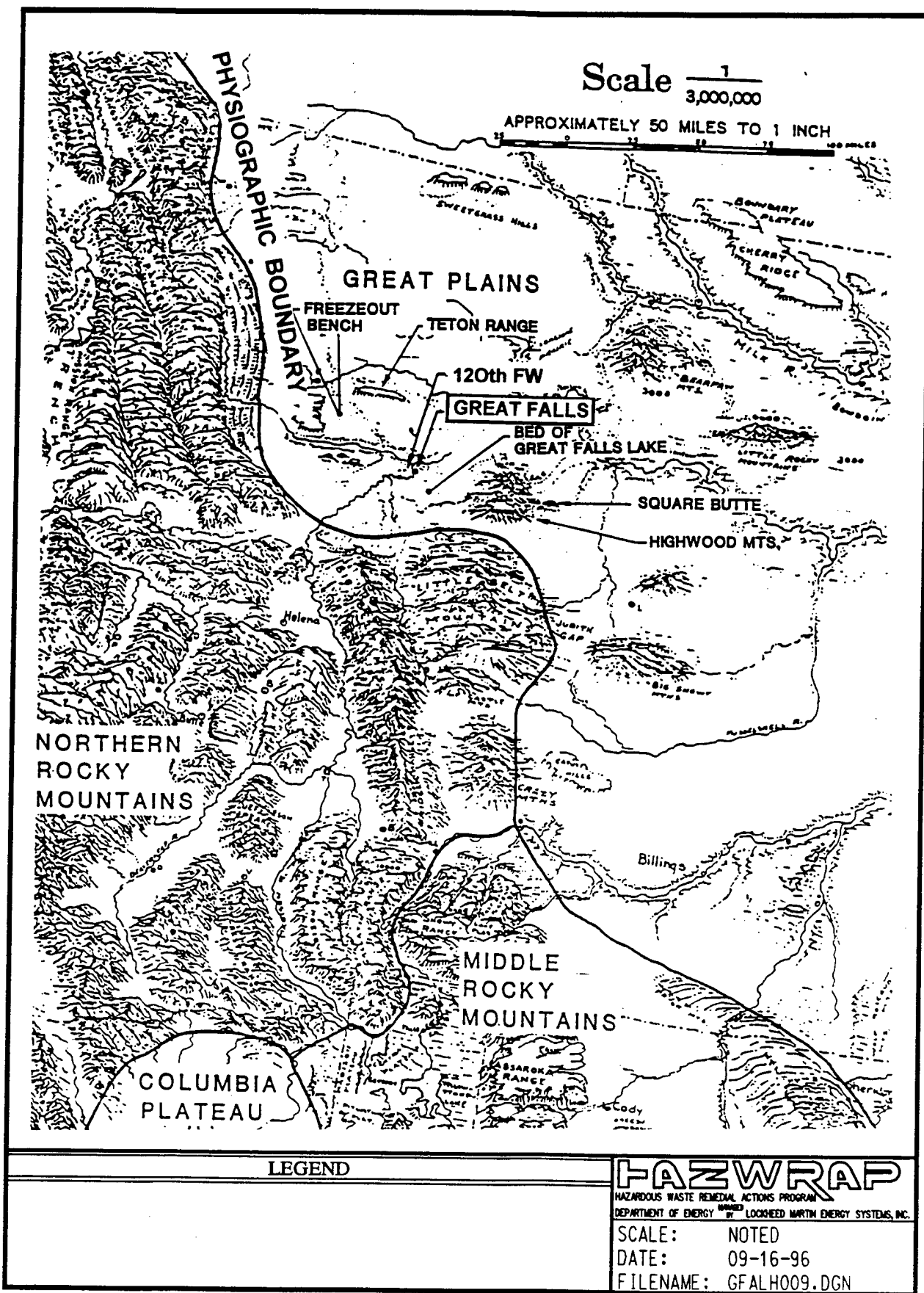


Fig. 3.3. Regional Physiographic Map. 120th FW Montana Air National Guard, Great Falls, Montana.

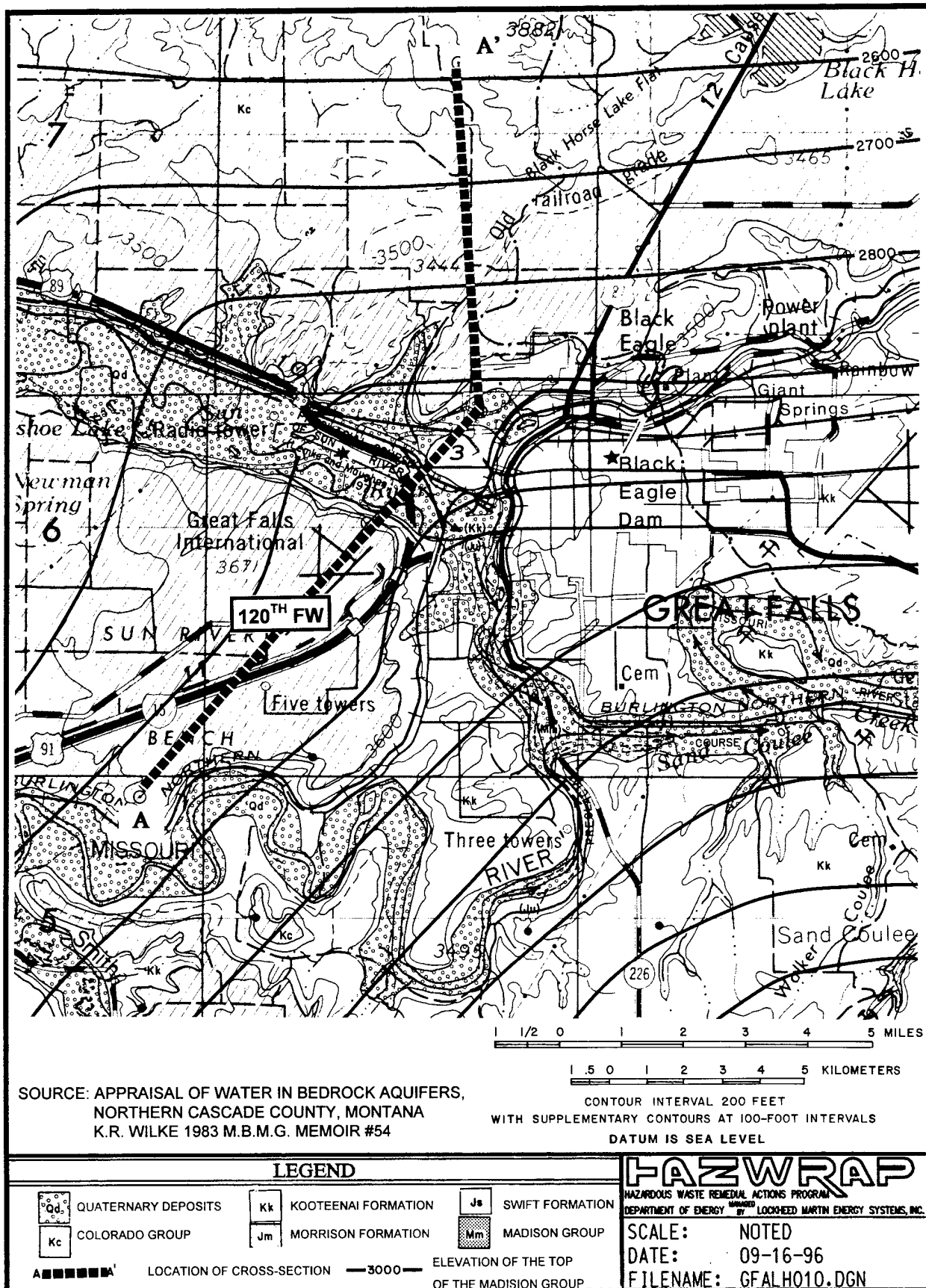


Fig. 3.4. Geologic Map Great Falls Area. 120th FW Montana Air National Guard, Great Falls, Montana.

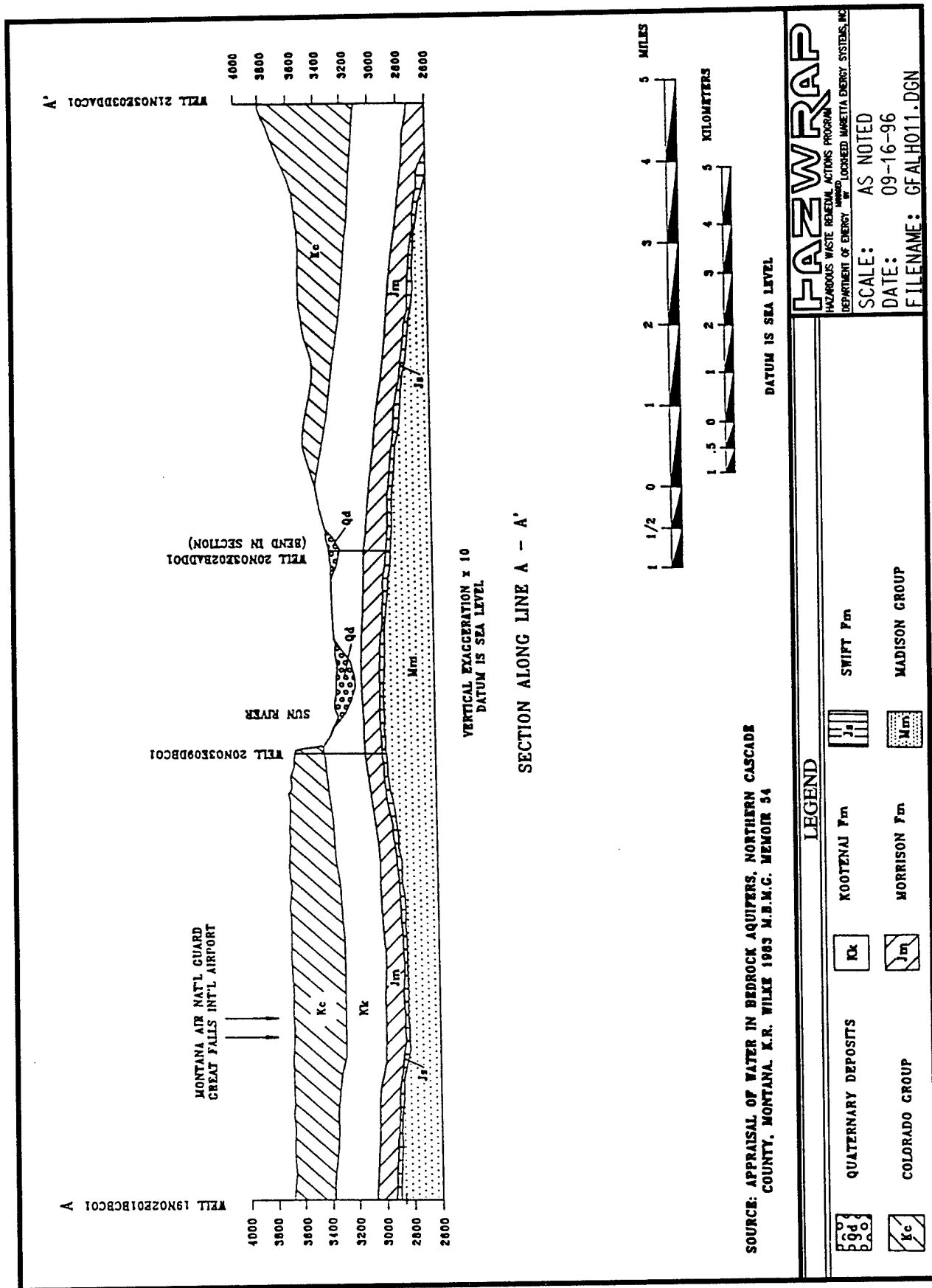


Fig. 3.5. Geologic Cross Section, 120 FW Montana Air National Guard, Great Falls, Montana.

				GEOLOGY	HYDROGEOLOGY	
QUAT				Alluvial and glacial sands and gravels	39% of all wells in Cascade County	
CRETACEOUS	COLORADO GROUP	BLACKLEAF FORMATION	TAFT HILL	15-250'	Sandstone, greenish gray glauconitic gray, and Shales, medium gray, soft, bentonitic to silty	No hydrogeologic data available
			FLOOD MEMBER	138-200'	Sandstone, light gray, very fine to medium grained cherty, massive bedded with vertical and horizontal joints in lower part Sandstone, tan, fine to medium grained, siliceous and argillaceous cement, interbedded with Shale, dark gray, sandy and silty and, Sandstone, tan gray and Siltstone, tan gray	Water table condition occur where aquifer is in contact with Quaternary deposits or Sun and Missouri Rivers. Described as perched due to underlying impermeable beds on Sun River Bench. Recharge mainly from infiltration of precipitation discharge by evapotranspiration, seeps and springs, pumpage from wells and subsurface flow.
		KOOTENAI FORMATION		350-400'	Shale and Siltstone, dark red, purple or greenish gray, nonmarine, interbedded with numerous Sandstone, light gray to buff, discontinuous with Limestone, lenticular, thin beds	Water table conditions found where Kootenai outcrops; perched conditions exist on Sun River bench. Some wells in the vicinity of Base completed in Kootenai and are used for domestic purposes. 27% of water wells in Cascade County completed in Kootenai.
			25-45'	Basal Sandstone unit, laterally extensive	Best aquifer in lowest most sandstone.	
	JURASSIC		MORRISON FORMATION		100-180'	Shale and Siltstone, mainly greenish gray, Limestone and Sandstone, minor amounts, discontinuous Coal/shale, carbonaceous
		SWIFT FORM.		5-20'	Sandstone, light gray, fine grained, cross bedded, calcareous cement	Swift and Upper Madison act as single aquifer generally confined except in the Great Falls area where exists as water table aquifer. Recharge from infiltration of precipitation, run off in outcrop areas and leakage from overlying aquifers.
MISS	MADISON GROUP	MADISON FORMATION		Limestone, dense w/ interbeds of Shale, with some chert interbeds, solution porosity in upper part		
LEGEND						
SOURCE: After Wilke, 1983 and Patton, 1990					HAZARDOUS WASTE REMEDIAL ACTIONS PROGRAM DEPARTMENT OF ENERGY LOCKHEED MARTIN ENERGY SYSTEMS, INC.	
					SCALE: NOT TO SCALE DATE: 04-15-97 FILENAME: GFALH012.DGN	

Fig. 3.6. Stratigraphic/Hydrogeologic Column, Great Falls Area, 120th FW Montana Air National Guard, Great Falls Montana



member is reported to be 250 ft thick with beds thinning to the east (Fox 1996). The member consists predominantly of marine strata with medium gray, soft bentonitic clayey to silty shales and greenish gray, glauconitic sandstones.

The Flood Member is the first competent rock encountered at the installation. At the type section for the Flood Member, 5 miles southwest of Great Falls, the unit is 138 ft thick and ranges up to approximately 200 ft thick west of the Base (Wilke 1983). The Flood is composed of marine strata consisting of a lower unit of gray to tan gray sandstone and siltstone (22 ft thick at type locality), a middle interval consisting of interbedded sandstones and dark gray shale (44 ft thick at type locality), and an upper (66-ft thick unit at type locality) of cliff-forming sandstone.

Only the upper and middle units of the Flood Member were encountered during the RI activities. The upper sandstone forms the cliffs around the edge of the Sun River bench southwest of Great Falls. It consists of light-gray, very fine to medium-grained quartz and chert sandstone. The sandstone weathers tan-brown to red-brown and has either a clayey matrix or siliceous cement. The sandstone is characterized by massive bedding in the lower part with distinct vertical and horizontal joints; the upper part is characterized by irregular vertical joints and bedding plane partings. The contact between the upper and middle unit of the Flood is gradational.

The middle unit of the Flood consists of interbedded sandstone and shales. The sandstone is tan and fine to medium grained and weathers to a light tan gray; some sandstone beds are siliceously cemented, others are argillaceous and friable. The shale beds are dark gray and weather light gray, are both sandy and silty, and generally are calcareous. Occasionally, coal laminae may be present.

Although not penetrated by drilling activities during the RI at the installation, description of the following formations encountered by other drilling activities for water wells and other exploration activities are presented. The Kootenai Formation underlies the Flood Member and consists of 350 to 400 ft of nonmarine, interbedded dark red, purple, or greenish gray shales and siltstones with numerous discontinuous light gray to buff sandstones and a few thin limestone lenses. A widespread sandstone unit, generally 25 to 45 ft thick, occurs at the base of the unit. The Morrison Formation unconformably underlies the basal sand unit of the Kootenai and is about 100 to 180 ft thick. It is composed of varicolored, mainly greenish-gray interbedded shale and siltstone with some discontinuous limestone and sandstone beds. Coal or carbonaceous shale occurs towards the top of the Morrison (Wilke 1983). The Swift Formation lies unconformably beneath the Morrison and is 5 to 20 ft thick in the Great Falls area. The formation is mostly fine-grained, light gray, cross-bedded quartz sandstone of marine origin and is cemented predominantly with calcite. The Madison Group occurs unconformably beneath the Swift and is composed of dense limestone with interbeds of shale and some chert beds. In the study area, water wells penetrate the top of the Madison, which generally contains secondary solution porosity.

### 3.3.2 Local Geology

The near surface geology of the installation is characterized by a relatively thin layer of brown sandy and silty clays and clayey sands with gravel and weathered and broken sandstones both interpreted to be derived from the Taft Hill Member of the Colorado Group. This surficial soil

layer is commonly 2 to 3.5 ft thick with weathered sandstones ranging from 8 ft to as much as 20 ft below ground surface (bgs). These unconsolidated and weathered deposits are underlain by the more competent sandstones of the upper Flood Member. Only the upper and middle units of the Flood Member were penetrated during the drilling of monitoring wells on the installation; a description of these strata and cross section(s) depicting their lateral and vertical distribution are included in Sect. 5.1.1.2.

### 3.4 SOILS

Soil cover at the Great Falls International Airport and the Bases consists predominantly of soils belonging to the Castner loamy fine sand and Ticell-Castner complex; lesser portions are covered by the Ipano loam and the Azzaar fine sandy loam (Soil Conservation Service 1973). Distribution of these soils is shown on Fig. 3.7. The Castner series, which dominates in the area investigated by the RI activities, consists of shallow well-drained soils formed in material weathered from fragmented sandstone. Such soils are often termed channery soils.

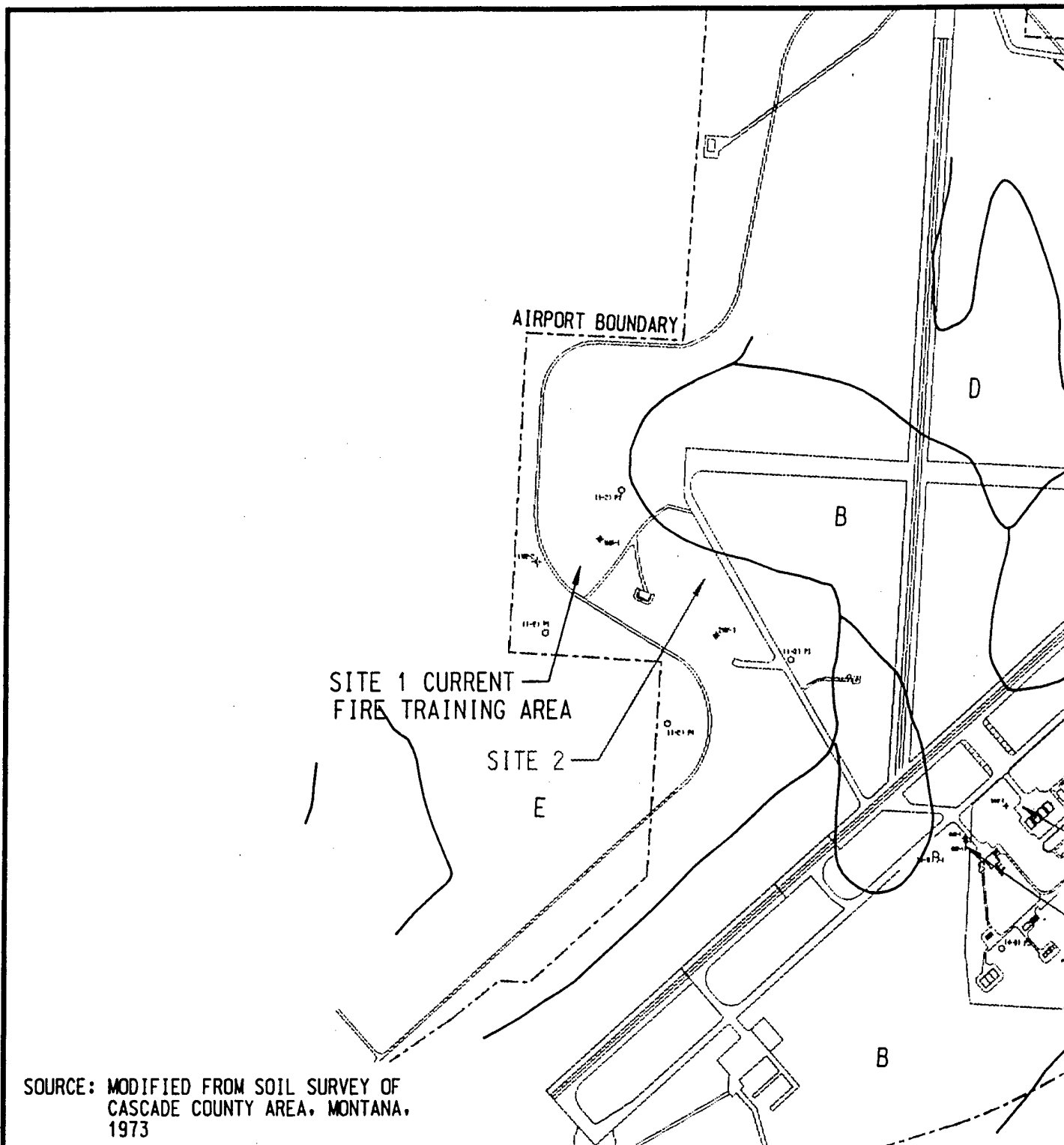
In a representative soil profile, the surface layer is about 6 in. of dark grayish brown loamy fine sand and 4 in. of calcareous very dark grayish brown channery loam. Permeability is moderate, surface runoff is low, and the available water capacity is very low. The erosion hazard from wind is severe and slight from water. The typical thickness of the overall soil profile ranges from 20 in. to greater than 40 in.

### 3.5 HYDROGEOLOGY

#### 3.5.1 Regional Hydrogeology

On the Sun River, bench groundwater is present in each of the geologic units described above (see Fig. 3.6). Regional groundwater flow in the area is to the west-northwest. The shallowest groundwater is found in the upper sandstone member of the Flood. Off the Sun River bench but within Cascade County, alluvial and glacial deposits are important aquifers and constitute about 39% of all wells (Patton 1990). The second most widely used aquifer is sandstone of the Kootenai Formation, representing slightly over 27% of wells. Other bedrock formations are used to a lesser extent, but altogether bedrock formations provide water for about 60% of the wells in Cascade County (see Fig. 3.6).

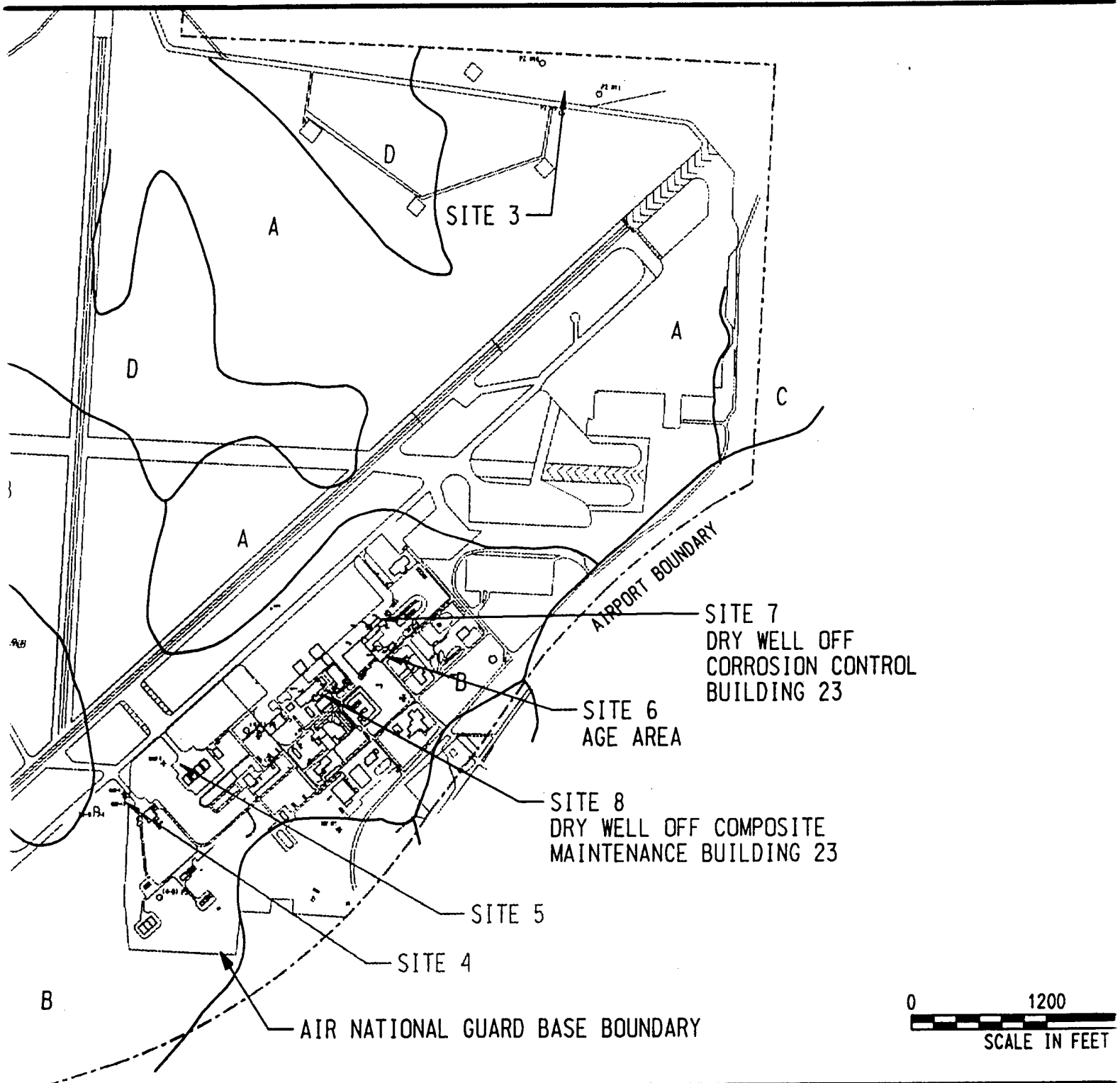
Wells completed in the Flood member commonly range from 20 ft to 100 ft bgs and are an important source of water for domestic and stock use. Reported well yields range from 6 to 40 gal/min (Wilke 1983). Relatively impermeable shale in the underlying Kootenai Formation, or possibly the middle shaly beds within the middle Flood, retard the vertical movement of groundwater and cause perched conditions (Wilke 1983). Water levels in wells completed in the Flood are about 300 ft higher in elevation on the bench than water levels in other areas. To the north and west, conditions gradually change from perched to water table to confined; water table conditions occur where the aquifer is in contact with overlying Quaternary deposits or with direct recharge from the Sun and Missouri Rivers and their tributaries.



#### LEGEND

- A TICELL-CASTNER COMPLEX, 0 TO 4% SLOPES
- B CASTNER LOAMY FINE SAND, 0 TO 3% SLOPES
- C YAWDIM-ROCK OUTCROP COMPLEX, 25 TO 70% SLOPES
- D IPANO LOAM, 0 TO 4% SLOPES
- E AZAAR FINE SANDY LOAM

Fig. 3.7. Soils Map, Great Falls International Airport Area,

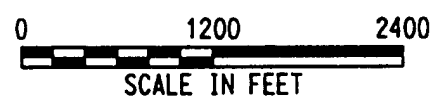
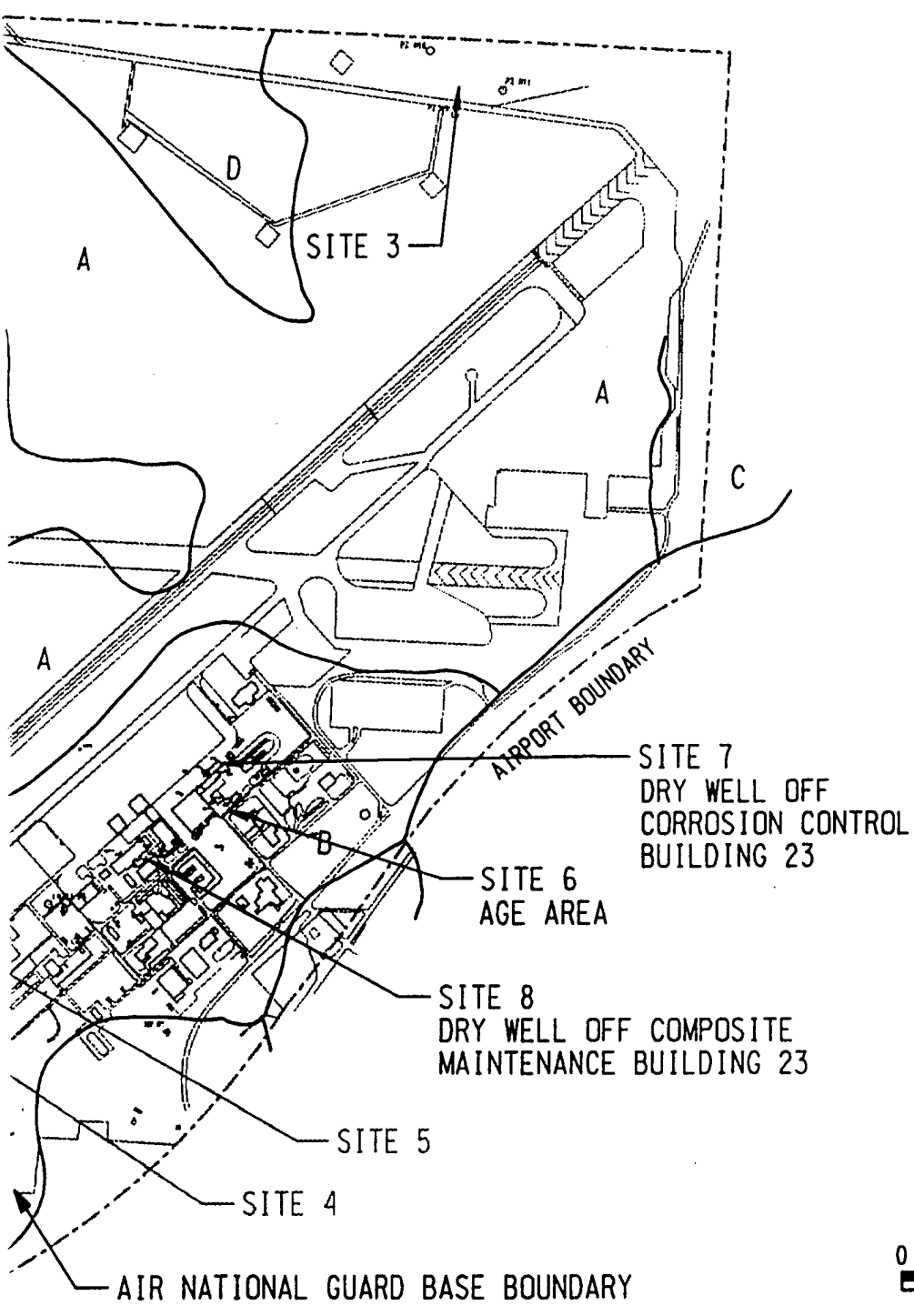


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national Airport Area, 120 FW Montana Air National Guard, Great Falls Montana.

2



<b>HAZWRAP</b>	
HAZARDOUS WASTE REMEDIAL ACTIONS PROGRAM	
DEPARTMENT OF ENERGY <small>POWER</small> LOCKHEED MARTIN ENERGY SYSTEMS, INC.	
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120 FW Montana Air National Guard, Great Falls Montana.

3

Recharge to the Flood Member on the Sun River bench is mainly from infiltration of precipitation. Discharge is by evapotranspiration, seeps and springs around the edge of the bench, pumpage from wells, and probably some subsurface outflow to the west down the aquifer dip.

Groundwater movement in the Flood is generally downdip, or to the northwest, except near outcrop boundaries. Consequently, local gradients at the installation are influenced by proximity to cliffs and local topographic features. This is evidenced by the presence of springs along the cliffs that surround the bench. Limited water quality data are available for the Flood and indicate the water is of a sodium sulfate and sodium bicarbonate type with dissolved solids concentrations of around 2700 mg/L.

Although not penetrated by drilling associated with the RI at the installation, the basal sandstone and the discontinuous sandstones of the Kootenai Formation also form an important aquifer in the area (see Fig. 3.6). Water levels reflect water table conditions, although some water levels on the bench may be perched (Wilke 1983). Similar to the Flood, the Kootenai is believed to become confined north and west of the bench. Some wells in the vicinity of the Base are completed in the Kootenai. These wells are used for domestic purposes. Well yields are reported to range from less than 5 to 50 gal/min with water levels ranging from 24 to 115 ft bgs. Similar to the Flood, groundwater movement of the Kootenai is thought to be northwest following the regional dip, although local gradients may also be influenced as with the Flood. The water of the Kootenai characteristically contains magnesium, sodium, bicarbonate, and sulfate with dissolved concentrations ranging from 558 to 1550 mg/L (Wilke 1983).

Similar to the Kootenai, rocks of the Morrison and Madison-Swift aquifers were not investigated during the RI activities. The water-bearing units of the Morrison Formation are relatively undefined, with sandstone units of varying thickness and areal extent supplying water to wells. There are a few domestic wells in the vicinity of the Base completed in the Morrison. Reported yields range from 4 to 72 gal/min with water levels ranging from 52 to 308 ft bgs. Limited water quality data are available for the Morrison and reflect no common chemical characteristics; dissolved solids concentrations range from 908 mg/L to 1,480 mg/L. The upper limestone of the Madison and the Swift sandstone are considered as a single aquifer (see Fig. 3.6). The Madison-Swift aquifer is generally confined except in the area around Great Falls, where water levels indicate water table conditions. Reported yields from wells in the aquifer range from 3 to 338 gal/min, with water levels ranging from 7 to 340 ft bgs. Groundwater movement is typically to the northwest. Water quality data reflect a calcium sulfate type water with large concentrations of iron and fluoride and dissolved solids of 520 to 1,570 mg/L. The Madison-Swift is recharged from precipitation infiltration and runoff in outcrop areas and from leakage of overlying aquifers (Wilke 1983).

The unconsolidated Quaternary deposit aquifer in the Great Falls area is generally less than 40 ft thick and contains alluvium of the Sun and Missouri Rivers. These deposits overlie and are hydraulically connected to parts of all the bedrock aquifers in the Great Falls area with the exception of the Colorado group on the Sun River bench (Wilke 1983).

### **3.5.2 Local Hydrogeology**

The installation obtains potable water from the City of Great Falls. The City of Great Falls' water supply is obtained from the Missouri River. Local groundwater data in the immediate vicinity of the Montana ANGB are limited and are based largely on information derived from the previous SI (Engineering Science 1992) and the Montana Bureau of Mines and Geology (1983, 1990). Information on the well locations and names of the aquifer from which production occurs in the wells within a 4-mile radius of the installation is supplied on Fig. 3.8.

## **3.6 SURFACE WATER HYDROLOGY**

The installation is located approximately 2 miles west southwest of the confluence of the Missouri and Sun Rivers (see Fig. 3.9). The Missouri River originates on the eastern flank of the Continental Divide, flowing in a northeasterly direction, and bisects and traverses Great Falls Township from the south to the northeast. The Sun River flows east from its headwaters near the Continental Divide and joins the Missouri at Great Falls. Several springs, sourced probably from the upper unit of Flood member of the Blackleaf Formation, occur to the north of the installation and flow from the bench edge into the Sun River. The springs are observed to discharge from fractures in the sandstone. The Sun River is characterized as a gaining river in the Great Falls area.

The installation's stormwater runoff drains into the Sun River via a network of swales, ditches, culverts, collector pipes, and trunk lines. Other runoff at the installation flows into sanitary sewers and eventually reaches the city's wastewater treatment facility, which discharges to the Missouri River. Surface drainage at the installation is shown on Fig. 3.10.

## **3.7 THREATENED AND ENDANGERED SPECIES AND CRITICAL HABITATS**

The Montana Department of Fish, Wildlife, and Parks reviewed their files with respect to the presence of rare, threatened, or endangered animals, plants, and natural communities and/or significant wildlife habitat within a 4-mile radius of the Great Falls International Airport. Table 3.1 lists for the State those species that are endangered or threatened.

The Bald Eagle (threatened) and Peregrine Falcon (endangered) fly over Great Falls during spring and fall migrations; no problems regarding these species have been reported to date. The Piping Plover, Least Tern, and Pallid Sturgeon are found along the Missouri River, but only in the eastern part of the State below the Fort Peck dam.

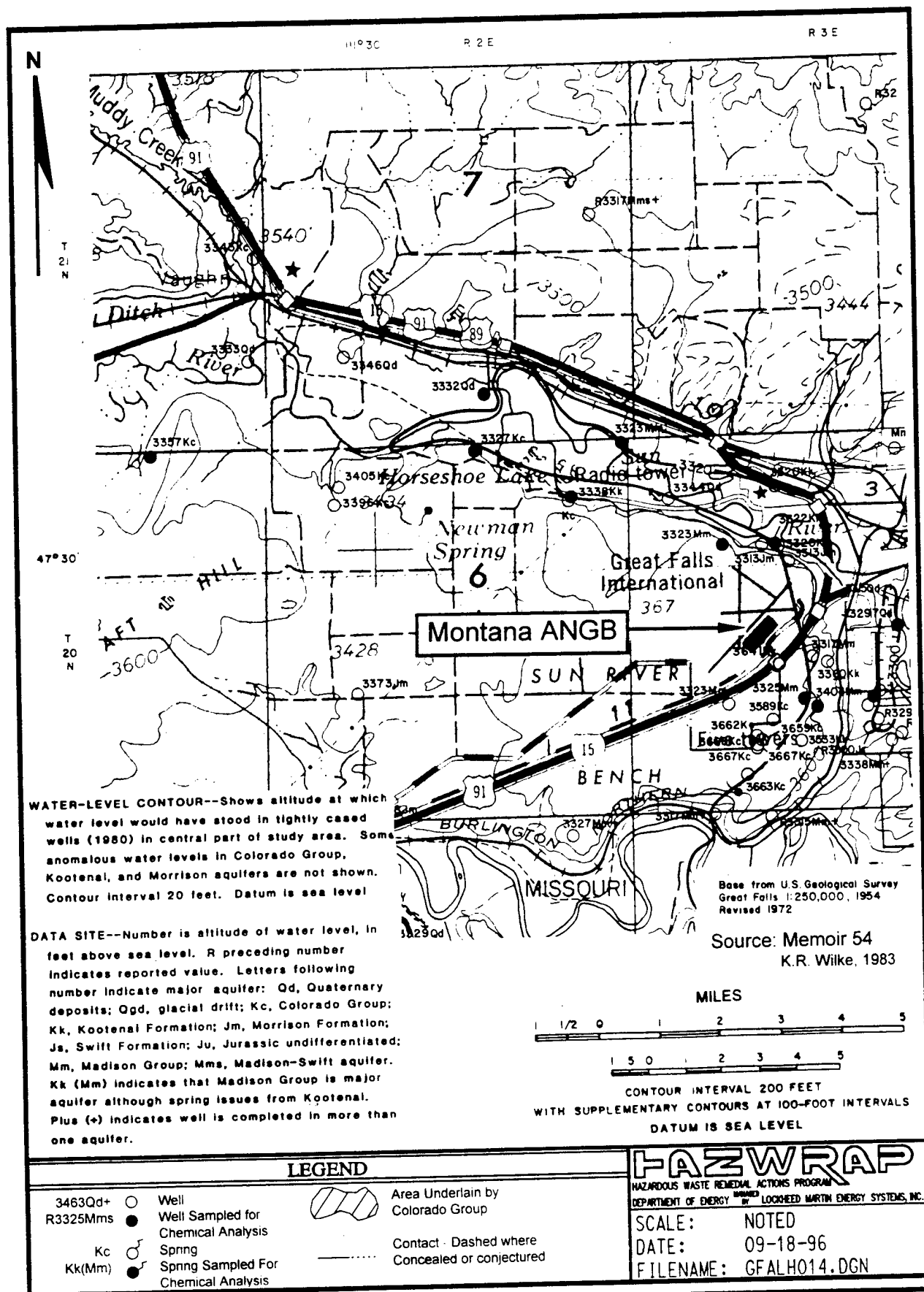


Fig. 3.8. Location of Water Wells. 120th FW Montana Air National Guard, Great Falls, Montana.



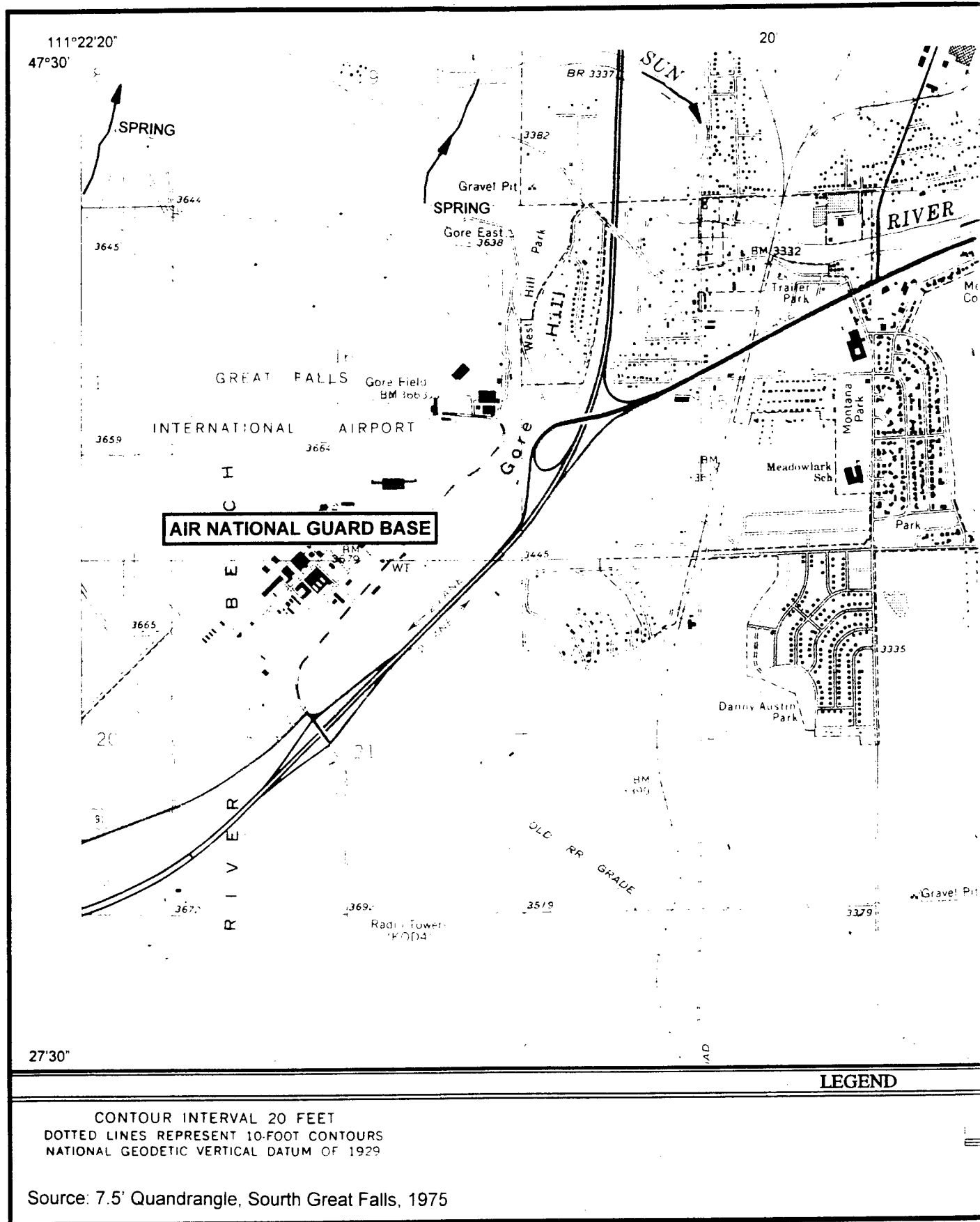
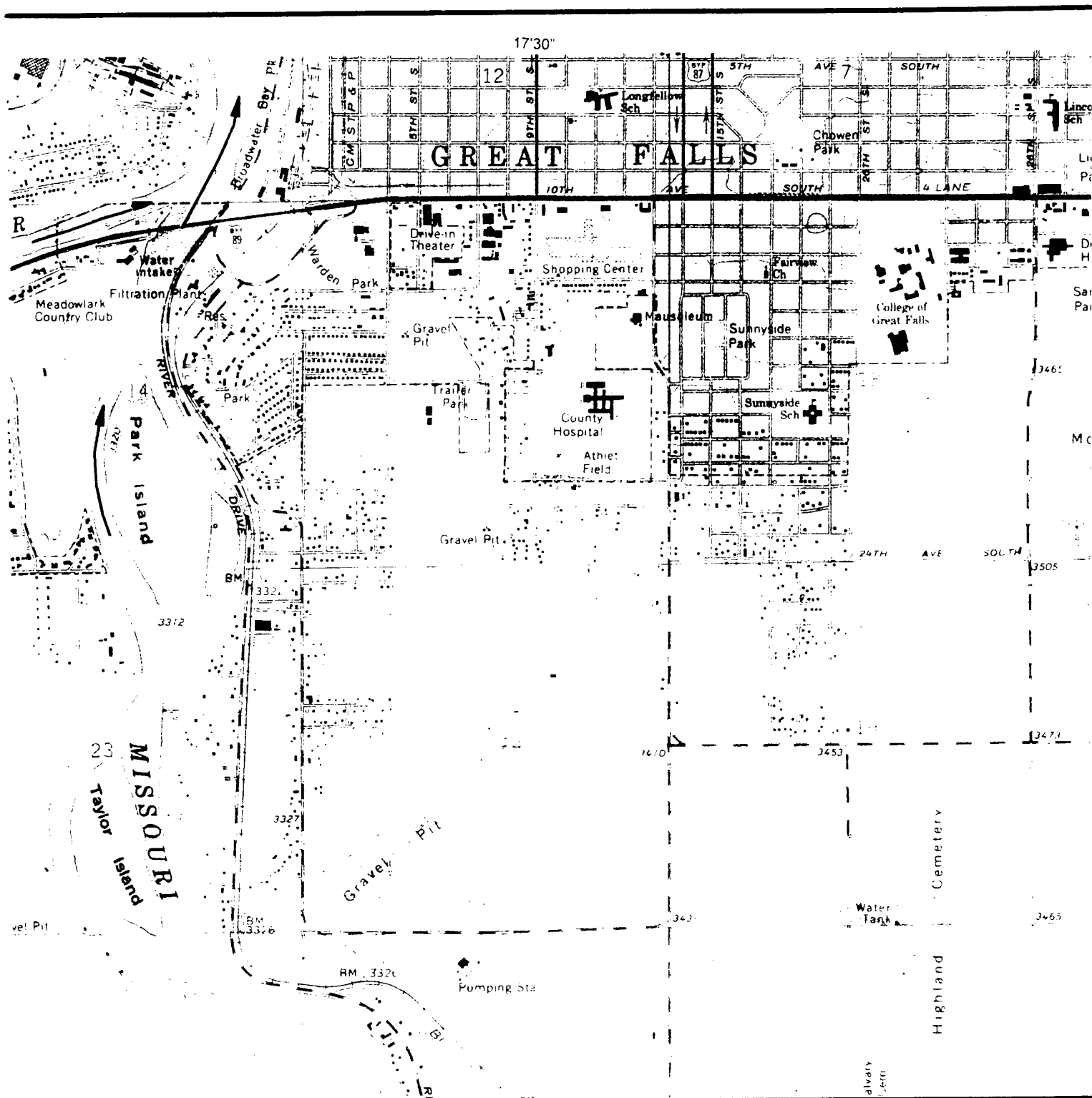


Fig. 3.9. Surface Water Hydrology Map, Great Falls Area

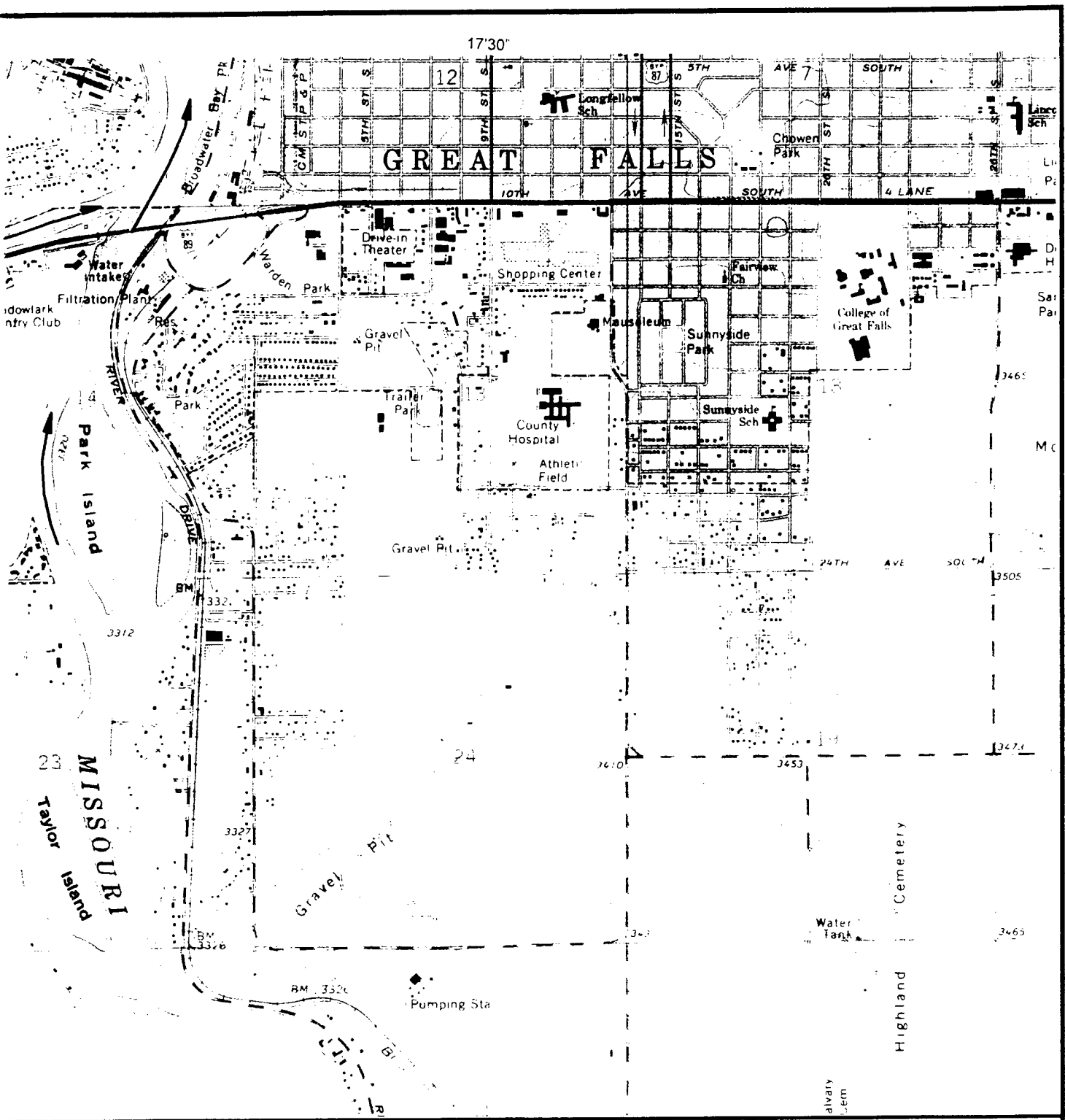


**HAZWARP**

HAZARDOUS WASTE REMEDIAL ACTIONS PROGRAM  
DEPARTMENT OF ENERGY LOCKHEED MARTIN ENERGY SYSTEMS, INC.

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Area, 120 FW Montana Air National Guard, Great Falls Montana.



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DEPARTMENT OF ENERGY LOCKHEED MARTIN ENERGY SYSTEMS, INC.

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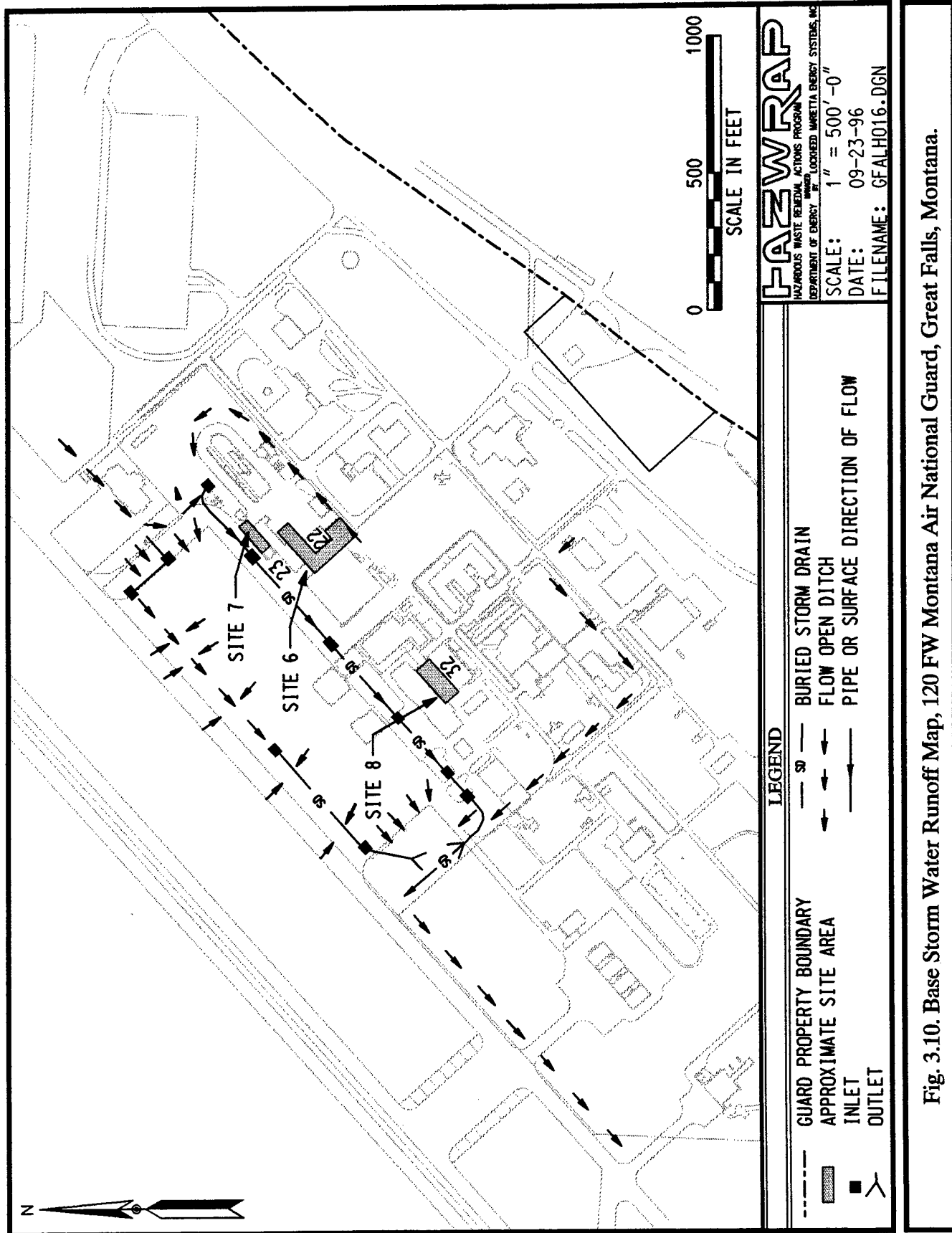


Fig. 3.10. Base Storm Water Runoff Map, 120 FW Montana Air National Guard, Great Falls, Montana.

**Table 3.1**  
**Threatened and Endangered Species - Montana**

ENDANGERED (E) - Any species that is in danger of extinction throughout all or a significant portion of its range.

THREATENED (T) - Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

<u>Common Name</u>	<u>Scientific Name</u>	<u>Status</u>	<u>Range-Montana</u>
Black-footed Ferret	<u>Mustela Nigripes</u>	E	Prairie dog complexes; East. MT
Grey Wolf	<u>Canis lupus</u>	E	Forest; West. MT
Grizzly Bear	<u>Ursus aretos horribilis</u>	T	Alpine/subalpine coniferous forest; West. MT
Bald Eagle	<u>Haliaeetus leucocphalus</u>	T	Forested riparian; statewide
Peregrine Falcon	<u>Falco peregrinus</u>	E	Forests near cliffs; statewide
Whooping Crane	<u>Crus americana</u>	E	Wetlands; migrant statewide
Piping Plover	<u>Charadrius melodus</u>	T	Missouri River sandbars, alkaline beaches; NE MT
Least Tern	<u>Sterna antillarum</u>	E	Yellowstone, Missouri River sandbars, beaches; East. MT
Pallid Sturgeon	<u>Scaphirhynchus albus</u>	E	Bottom dwelling; Missouri, Yellowstone Rivers
White Sturgeon (Kootenai River pop.)	<u>Acipenser transmontanus</u>	E	Kootenai River, NW MT
Water Howellia	<u>Howellia aquatilis</u>	T	Wetlands; Swan Valley, NW MT

## **4. FIELD PROGRAM**

The RI field program activities that HAZWRAP and its subcontractor, OPTECH, implemented at IRP Sites 6, 7, and 8 of the Base are described in the following sections. The RI field program was conducted according to the rationale and methodologies presented in the Final RI WP (OPTECH April 1996). As outlined in the RI WP, additional fieldwork was also performed at IRP Site 1.

### **4.1 FIELD PROGRAM SUMMARY**

Both screening and confirmation activities were performed during the RI. Screening activities consisted of field screening of soil cuttings with a photoionization detector (PID) during the augering of soil borings. This method was used to select a third sample interval at an intermediate depth from the boring for fixed-base laboratory analysis; originally intended to be an optional sample activity, the third sample was selected from each soil boring performed. The brass liners inserted in each spoon were immediately screened with the PID upon opening each spoon and the organic vapor concentration noted.

Confirmation activities conducted during the RI included the collection of soil and groundwater samples for Level C laboratory analyses. A total of ten obligatory soil borings were advanced by hollow-stem augering and sampled. Locations of the borings were predetermined by soil boring results and geophysical surveys of the previous SI (Engineering Science 1992). In addition, three optional soil borings were drilled and sampled. Samples were collected by driving stainless steel split spoons with brass sampling liners. Nine obligatory and one optional groundwater monitoring wells were drilled using air rotary methods. The location of wells was determined by an initial round of groundwater measurements and previous groundwater analytical data (Engineering Science 1992). Surface casing to case-off a shallow perched zone was installed at six of the well locations.

Quick turnaround analyses were performed for VOCs from soil samples collected at total depth for soil samples and at the depths at which surface casings were set at Sites 6 and 7 monitoring wells. Similar rapid turnaround analysis was also performed in groundwater samples from two monitoring wells.

As part of the screening and confirmation activities, geologic and hydrogeologic observations and measurements were collected to obtain information on soil properties and groundwater flow characteristics. These included geotechnical sampling, hydraulic conductivity tests, groundwater elevation measurements and a Base survey.

### **4.2 DEVIATIONS FROM THE WORK PLAN**

Changes to the field investigation methodologies are documented on five Field Change Request (FCR) forms, presented in Appendix A. The only significant deviation from the Work Plan (WP) was the termination of the on-site gas chromatograph (GC) as a soil field screening

methodology for selection of optional samples from soil borings for fixed-base laboratory analysis (FCR No. 4). An optional sample based on PID results was selected from each boring.

### **4.3 FIELD SCREENING ACTIVITIES**

Field screening activities consisted of screening soil samples based on PID readings using a Mini RAE Professional Unit with a 10.6-eV lamp. Weathered bedrock was generally encountered at around 3.5 ft bgs and hollow-stem augers were unable to be advanced beyond 8 ft bgs. After the augers were advanced in the weathered bedrock, soil cuttings were continuously monitored with the PID. When above-background readings were obtained from the cuttings, an intermediate sample point selection was made. A GC sample was initially collected from each spoon.

Although originally planned for the field program, screening activities consisting of on-site GC screening analysis of soils was not performed. The fact that a shallow and total depth sample were required, the shallowness of penetration achievable, and the method required to obtain the intermediate depth sample contributed to the abandonment of field screening with the GC. In addition, numerous and continuous operational start-up problems associated with the GC selected for use would have necessitated delay in the field program.

During the installation of the groundwater monitoring wells at two sites, samples were collected from the auger flights at the depth at which the 20 ft protection casing was to be set. These samples were sent for a quick-turnaround TPH analysis (EPA SW 846 Modified Method 8015) to assist in determining the disposition of cuttings and as a qualitative screening of the shallow level of TPH contamination at these well locations.

### **4.4 CONFIRMATION ACTIVITIES**

#### **4.4.1 Soil Borings**

A total of 13 soil borings were advanced at the three sites and 40 subsurface soil samples were collected and submitted for laboratory analyses. Ten of the borings were obligatory and three borings were optional. Boreholes were advanced using a truck-mounted Mobile B-59® drill rig equipped with continuous-flight hollow-stem, 4¼-in. inside diameter (ID) augers. A combustible gas indicator (Industrial Scientific® MX 251) with alarms for percent oxygen and percent lower explosive limit (LEL) was maintained on the rig during all augering operations.

Two predetermined soil sampling intervals had been established in the WP; one from 1–2 ft bgs and the second at the depth of refusal at the interface between the surficial soil and weathered bedrock. It was inferred from the SI previous investigation (Engineering Science 1992) that auger penetration could not be achieved below this depth. In general, weathered bedrock was encountered at depths of approximately 3.5 to 4 ft bgs; however, refusal occurred generally at around 8.5 to 10 ft. The deeper sampling interval was selected whenever possible. A third sample from an intermediate depth was described as an optional sample to be sent for fixed-base laboratory analysis.

To obtain an intermediate depth sample, augers were advanced through the weathered rock, back-spun or reversed to collect approximately 6 in. of the rock/soil cuttings back in the hole. This interval would then constitute the initial soil to be sampled with the split-spoon and brass liners. Often, little to no penetration would be made on driving the spoon beyond the cuttings already reversed back into the hole. This methodology was also used to obtain the bottom sample from the boring. Because of the method necessary to obtain the intermediate sample and early problems associated with the GC, a third sample was sent from each boring.

#### **4.4.2 Monitoring Well Installation and Development**

##### **4.4.2.1 Monitoring Well Installation**

Ten groundwater monitoring wells were installed; nine were obligatory and one was optional. All but one well were drilled and set in bedrock with a 5.875-in. outside diameter (OD) percussion air hammer bit and a ReichDrill® T-650W air rotary rig; one of the monitoring wells was drilled with air but using a roller or tri-cone bit. Five of the wells at two sites were double cased; the hollow-stem auger rig was used to drill and install the 20 ft of surface casing set. Boring logs prepared from the drill cuttings and the monitoring well construction logs are included as Appendix B.

At two sites (Sites 6 and 7) the potential existed for the influx of groundwater from a shallow, 17 to 18-ft-deep perched water zone at the approximate weathered bedrock/bedrock interface. To prevent the infiltration of water from this surficial zone from commingling with the deeper bedrock aquifer, 6.625 OD/6.125-in.-ID-diameter protection casing was set to a depth of 20 ft bgs before deeper drilling proceeded. After the appropriate depth was reached, approximately 1 gal of cement/bentonite grout was added to entrain any soil cuttings that might be present at the bottom of the hole. A 2-ft thick seat of bentonite chips was added followed by 15 to 20 gal of cement/bentonite grout mix. The decontaminated steel casing was then run into the hole and pushed enough into the bentonite seal to seat. The top of the grout was measured with a decontaminated tag line; top of grout generally measured between 10 and 15 ft bgs. Additional grout mix was added to the annular ring outside the casing until it could be visually sighted. The casing was then further seated by pushing with the drill rig until no additional depth was attained. The surface casing was then allowed to set a minimum of 24 hr before the grout was drilled out with the air rig.

During the drilling of the bedrock wells none of the usual signs such as the "cutting of dust" or "blowing water out of the hole" after shutting down drilling operations for an hour or more after encountering groundwater were observable. The phrase "cutting the dust" is a standard driller's term used when drilling with air to refer to a decrease in the volume of powdered cuttings being blown from the borehole as a result of an influx of water. "Blowing water out of the hole" is the action that occurs when water enters an air-drilled borehole and is evacuated from the hole by the force of compressed air used to drive the air hammer. Initial wells were allowed to sit overnight waiting for partial fillup by groundwater; when blown out the next morning the well sometimes would still be dry. Cuttings obtained during the drilling were sometimes, but not consistently, damp.

After the well's total depth was reached, approximately 35 to 40 gal of potable water was added to the hole and the water column was surged from a depth of about 60 ft by raising and



lowering the water column at a frequency of 1 to 2 min for a period of 20 min. This technique was used to wash the sides of the hole free from any impacted dust and cuttings. After the surging, the bit was returned to the bottom of the hole, the water blown out, and the hole dried.

The monitoring wells were installed with 2-in., flush-jointed and threaded, schedule 40 polyvinyl chloride (PVC) casing with two 10-ft lengths of No. 10 slotted PVC screen with a 6-in. tapered end cap. During installation, stainless steel centralizers were set at the top and bottom of the 20-ft screen length; a third centralizer was set 20 ft above the top of the screen. Washed and bagged 20-40 mesh Colorado silica sand was used to backfill the overdrilled portions of each hole resulting from the uncertain depth of groundwater entry. Sand was added to a minimum of 2 ft above the top screen, and a bentonite seal ranging from 2-5 ft thick of Pure Gold Medium Bentonite Chips® was added and hydrated with potable water. As installation of the well was in competent bedrock, a tremie pipe was not used. Holes drilled in bedrock intervals of sandstone are not likely to bridge. In view of this and because centralizers would be in place creating difficulty in inserting the tremie pipe, its use was not considered necessary. The remainder of the borehole was completed with a cement-bentonite grout mix from the top of the bentonite seal to approximately 2-3 ft from surface.

All but one of the wells installed were flush-mounted wells with locking caps and 8-in.-diameter, bolt-down lids. The manholes were 12 in. deep and were placed in a neat Type I/II Portland® cement slurry. The one stick-up well (Site 1) was set with a 6-in.-diameter steel security riser with locking lid and three cement filled bollards.

#### **4.4.2.2 Monitoring Well Development**

The annular grout seal was allowed to set for at least 24 hr before well development. Monitoring wells were developed using disposable bailers and dedicated line or a stainless steel bailer and the drill rig. Where sufficient recharge of the well occurred, wells were developed by removing three borehole volumes. The equation used, which takes into account the estimated porosity of the sand pack, is presented along with the development logs in Appendix C. At the outset of bailing, pH, conductivity, temperature were measured with a calibrated Horriba® U-10 water-quality tester. The well was considered developed when the pH, conductivity, and temperature of the water were stabilized [ $\text{pH} \pm 0.1$  units, conductivity  $\pm 10$  micromhos per centimeter ( $\mu\text{mho/cm}$ ), temperature  $\pm 1^\circ\text{C}$ ]. Turbidity measurements were also recorded, but in some wells the water clarity, while acceptable for sampling, never attained 50 nephelometric turbidity units (NTUs). When the amount and rate of recharge was considered to be too slow to be practical to remove three borehole volumes, a lesser amount of three casing volumes was removed. This practice was verbally approved by the MDEQ. Most of the wells recharged at rates approximating 1-2 gal/hr. All development water was containerized in an 1100-gal polyethylene tank.

#### **4.4.3 Soil Sampling**

##### **4.4.3.1 Surface Soil Sampling**

A total of 40 subsurface soil samples were collected for fixed-base laboratory analysis. Confirmation samples were analyzed for VOCs according to EPA CLP 3/90 SOW, SVOCs by EPA CLP 3/90, TPH by EPA SW 846 Modified Method 8015 diesel-range organic and

gasoline-range organic, priority pollutant metals (PPM) by EPA Contract Laboratory Procedure (CLP) 3/90. Sampling and analyses were conducted according to HAZWRAP quality control (QC) level guidelines. A discussion of the quality assurance/quality control (QA/QC) evaluation is presented in Appendix D; laboratory data and validation summaries are presented in Appendix E. Copies of the chain-of-custody forms are included in Appendix F.

Samples were collected by driving a 2-ft-long by 3-in.-OD stainless steel split-spoon sampler with a 140-lb hammer inside the hollow-stem augers. Four 2½-in.-diameter brass sampling liners were assembled inside each split-spoon sampler. Both liners and split-spoons were decontaminated according to procedures presented in Sect. 4.6 before use and wrapped in aluminum foil until used. Upon retrieving and opening the split-spoon sampler, the liners were screened for VOCs with a PID. After PID screening, the bottom liner or the liner within the split spoon exhibiting the highest PID reading was selected for potential laboratory analysis for VOCs. The liner adjacent to the one selected for VOCs was then chosen for SVOC and PPM analysis. Each sample liner selected for fixed-base laboratory analysis was labeled and immediately capped with a Teflon square at each end and capped with a tight-fitting polyethylene cap; the liner selected for VOC analysis was capped first. The remaining liner(s) was used for geologic description. All sample liners were labeled and stored in a cooler containing double-bagged ice and a trip blank. Before packing the cooler and contents for shipment to the fixed-base laboratory, a temperature blank to verify the 4°C temperature was placed inside.

#### **4.4.3.2 Surface Soil/Sediment Sampling**

The collection of surface soil/sediment from a drainage ditch at Site 6 was considered as an optional field activity. The drainage ditch was found to be a shallow concrete-lined ditch with about 4 to 6 in. of sediment present. The location of the ditch is at the edge of the site boundary and extends several hundred feet to the northeast of the site. To the southwest, the terminus of the ditch has been covered with asphalt.

Three sediment samples were collected using a decontaminated brass liner. Similar to the soil boring samples, the sediment samples were stored in a cooler maintained at 4°C for shipment to the fixed-base laboratory. Samples were analyzed for VOCs, SVOCs, TPH, and PPM according to the same EPA protocols as the subsurface soils. During the SI (Engineering Science 1992) sampling was performed along the ditch; however, the volatile samples were composited in a stainless steel bowl and are considered invalid.

#### **4.4.3.3 Geotechnical Sampling**

Four geotechnical samples were collected from three soil borings at Site 6 and four samples from two borings at Site 8. Samples were collected in brass sleeves inside a stainless steel split spoon. When possible, the split spoon was pushed in an effort to obtain an undisturbed sample. The samples were sent to an analytical laboratory for porosity, moisture content, grain size, specific gravity, total organic content (TOC), and permeability determination. The results of these analyses are presented in Appendix G.

#### **4.4.4 Groundwater Sampling**

Groundwater samples were collected from 14 monitoring wells and submitted for laboratory analysis; ten of the wells were installed during the RI and three were existing wells from the SI.

One additional existing well from the SI was scheduled to be sampled but was not sampled because of the presence of free product. Before sampling each well and after a minimum of 24 hr from development, the wells were purged of at least three casing volumes of groundwater using disposable polyethylene bailers and dedicated nylon or polypropylene line. Similar to the development water, all purge water was containerized in a polyethylene tank. During purging, water quality parameters of pH, temperature, conductivity, and turbidity were measured. Sampling usually occurred within 3 hr of completion of purging. Several wells, however, did not recover to 80% of their original static water level within a 3-hr time period. These wells were bailed to dryness and sampled according to the availability of groundwater in the well. Sampling and purging logs from all wells are presented in Appendix C.

The first sampling event was performed from May 6 to May 16, 1996; a second round of samples was collected from July 7 to July 19, 1996. VOC samples were collected first, followed by SVOC, TPH, and PPM. Total and dissolved metals were collected; dissolved metals were collected and filtered using a Geopump® 2 peristaltic pump to pass water from the collection bottle through Tygon tubing and a  $\mu$ 0.45 disposable filter. All samples were sent for analysis of VOCs according to EPA CLP SOW 10/92, SVOCs by EPA CLP SOW 3/90, PPM for total and dissolved metals by EPA CLP 3/90, and TPH according to EPA SW 846 Modified Method 8015 (gasoline-range organics and diesel-range organics). Additional QA/QC sample volumes were collected as required per analyses. All samples were labeled and preserved according to the protocols presented in the WP (OPTECH 1996). Groundwater samples were shipped for fixed-base laboratory analysis according to the shipping and chain-of-custody (COC) procedures presented in the RI WP (OPTECH 1996).

#### **4.4.5 Dry Well Sampling**

Based on GPR surveys performed during the SI, soil samples were collected with hollow-stem augers and stainless steel split-spoon samplers with brass liners at the locations of two reported dry wells. Samples were analyzed for VOCs, SVOCs and PPM by EPA CLP SOW 3/90 and TPH by SW 846 Modified Method 8015. No physical evidence of any material that might have been used in the construction of the dry wells was noted at either location. At one presumed dry well location (Site 7), bedrock was encountered at 3.7 ft bgs. Because of this, the presence of the dry wells could not be confirmed. No fluid was encountered at either location.

A sealed and buried additional possible dry well was found with a magnetic detector near (6 ft) the initially reported dry well location at Site 6. Its presence was verified on construction drawings. The metal lid to the cleanout pipe was buried 1 ft below the asphalt roadway, but a 3-in.-diameter rubble-filled hole was present through the cover. Approximately 2.4 ft of fluid was present in the separator. An analytical sample of the contained fluid was collected with a disposable bailer and sent for analysis of VOCs, SVOCs, and PPM (total metals only) according to CLP methods and TPH according to Modified Method 8015.

#### **4.4.6 Free Product Sampling**

Before the drilling and installation of the RI wells, one of the existing monitoring wells at Site 7, 7-MW-1, was found to have approximately 1.32 ft of free product on the water table as measured with an ORS® oil/water interface probe; the odor and color of the light nonaqueous-phase liquid (LNAPL) was consistent with jet propellant (JP) fuel. A sample using a

40-mL VOA vial was collected from the well with a bailer and a sample of JP-8 was obtained from the nearby and upgradient base POL Facility to be used as a standard. Both the unknown sample and the JP-8 were sent to an analytical laboratory for "fingerprinting." The analytical laboratory already had a sample of JP-4 for a second standard for comparison.

#### 4.5 AQUIFER CHARACTERIZATION

Aquifer slug tests on seven monitor wells were performed to characterize aquifer properties by providing hydraulic conductivity (k) data for the fine-grained sandstone/siltstone bedrock. Both rising-head ("slug-out") and falling-head ("slug-in") tests were conducted on the aquifer.

The technique is based on measurements of the water level as a function of time after withdrawing a slug of known volume from the monitor well.

The equipment used for slug testing included a Hermit Environmental Data Logger® model SE1000C (serial No. 1KC-831), manufactured by *In Situ*, Inc. of Laramie, Wyoming. Also used was a pressure transducer model PTD-260 (serial #203217), manufactured by *In Situ*, Inc. Either an acrylic slug (1¼ in. in diameter and 4 ft long) or a PVC slug (1¼ in. in diameter and 2½ ft long) was used to produce the initial water displacement.

Before testing, the monitor well was developed and the water level allowed to stabilize. The slug was decontaminated using standard procedures before performing the slug test.

Immediately upon opening the monitoring well, the headspace was screened for the presence of volatile organic vapors using a PID. Next, the initial water level was measured and recorded in the field logbook and the pressure transducer was placed in the monitor well and allowed to equilibrate. The proper operating parameters such as time, date, test number, sample rate, number of inputs, data type, and scale factor and offset values of the transducer were inserted to properly program the data logger for the slug test. The decontaminated slug was rapidly lowered into the monitor well in such a manner as to minimize turbulence and splashing. The injection of the slug created a nearly instantaneous rise in the water level or hydraulic head as well as some transient oscillations (minimized by the smooth slug injection). After the initial rise, the water level of the monitor well dropped as it returned to equilibrium. The water-level altitudes were recorded by the data logger.

After equilibrium was attained, the slug was rapidly and smoothly removed from the monitor well and the subsequent rise of the water level in the monitor well versus the time since the start of the test was also recorded by the data logger.

After the slug test was completed, the data were downloaded onto a computer and printed using a portable printer.

The method used for analysis of the slug test data depends on the setting of the monitor well being tested. For monitor wells in unconfined conditions, as in the groundwater encountered during the RI, the Bouwer and Rice (1976) method is the appropriate method to use for reduction of the slug test data to determine values of hydraulic conductivity. The Bouwer and Rice method can also be used for semiconfined and confined conditions (Bouwer 1989). The

static water table intersected below the top of the screen; therefore, the slug test data were obtained from monitor wells that are screened in unconfined conditions.

The data plots and data reduction for the Bouwer and Rice method were accomplished using the AQTESOLV® software package Version 2.0 developed by Geraghty & Miller (1994). The slug test data analyses using Bouwer and Rice (1976) method is presented Appendix H along with the data plots.

#### **4.6 EQUIPMENT DECONTAMINATION**

Major equipment such as drilling rigs, hollow-stem augers, drill bits, surface casing for the monitoring wells, etc., were decontaminated before beginning work at the installation. Subsequent decontamination of all downhole equipment was conducted between soil boring and monitoring well locations. Additionally, the back of the drilling rigs used was decontaminated between sites. Decontamination and equipment staging activities were conducted in a designated area to the southeast of Building 23. Major equipment decontamination consisted of steam cleaning with pressurized hot water (water temperature, approximately 180°F) and was conducted over a temporary decontamination pad built to contain waters and sediments derived during equipment cleaning. Protective over-spray protection was constructed. Waste waters and suspended sediment contained in the temporary holding pad were routinely pumped into adjacent large-volume polyethylene tanks.

Sampling equipment that directly contacted soil and water environmental samples such as split-spoon samplers, brass sampling liners, stainless steel sampling knives, disposable bailers, and attachments were decontaminated between and before sampling as follows.

- scrubbed and washed with potable water and laboratory-grade detergent (Liquinox);
- rinsed with potable water;
- rinsed with American Society of Testing and Materials (ASTM) Type I water;
- rinsed with pesticide grade isopropanol;
- air dried; and
- wrapped in aluminum foil, shiny side out (if not used immediately).

Sampling equipment decontamination was conducted in plastic buckets underlain by plastic sheeting in areas adjacent to the sampling activities. Contained wastewaters were transferred to a large-volume polyethylene tank.

#### **4.7 SURVEYING**

Site surveying was conducted by Delta Engineering, Inc., Great Falls, Montana. Planar coordinates for the State of Montana were not available; therefore, horizontal coordinates were tied into local survey grid bench marks developed for the Base and the adjoining Great Falls International Airport. All site survey results are presented in Appendix I.

## **4.8 INVESTIGATION-DERIVED WASTE**

Waste materials generated from the RI field operations consisted of purge and development water, decontamination fluids, soil and bedrock cuttings, and personal protective equipment (PPE) and other disposable supplies. A total of 73 drums of investigation-derived waste (IDW) was generated during the investigation. All drums were secured with lids and marked as to contents and, when applicable, as to boring or well number and depth interval. The drums were staged on the asphalt area at Site 7 behind and to the southeast of Building 23. An inventory of the drums is included as Appendix J. Two polyethylene tanks containing development and purge water and decontamination fluids are listed separately in the same appendix.

### **4.8.1 Personal Protective Equipment and Consumable Supplies**

PPE and other expendable supplies (such as disposable bailers, nylon line, paper towels, tape, etc.) were placed in plastic bags and placed in two 55-gal drums and stored at the designated staging area. These drums were approved by the MDEQ for disposal through the existing waste disposal mechanism at the Base.

### **4.8.2 Soil and Bedrock Cuttings**

All soil from the hollow-stem augering and drill cuttings from the bedrock wells were containerized in 55-gal drums. Drill cuttings from the hollow-stem auger drill rig were containerized separately from those of the air-drilled monitoring wells. Final disposition of the contents of the 11 drums containing cuttings from the soil borings was determined upon receiving and reviewing the results of soil boring samples sent for fixed-base laboratory analysis. To further aid in the disposition, soil samples for SVOCs, Toxicity Characteristic Leaching Procedure (TCLP), and metals were composited from the drums on a site-by-site basis and a VOC and TCLP sample collected from the drum with the highest PID reading, again on a site-by-site basis. In addition, the Resource Conservation and Recovery Act (RCRA) characteristics ignitability, corrosivity, and reactivity (CN and S<sub>2</sub>) were run. None of the samples analyzed exceeded RCRA standards. The results of these analyses are presented in Appendix J.

Monitoring wells were installed either upgradient or downgradient from any potential area of soil/bedrock contamination. Analytical data indicated cuttings were not contaminated above ARARs and written approval was granted (Appendix J) by the MDEQ to spread the contents of the soil drums at a predetermined location to the west of IRP Site 4 at the west side of the Base. This approval also included those drums containing potable water used in the surging of the borehole that had been drummed along with the cuttings from the bottom of the hole.

Cuttings generated from that portion of the drilling necessary to install the 6-in. surface casing at Sites 6 and 7 were containerized in separate drum(s) from the rest of the borehole. Soil samples from these drums were analyzed for VOCs; a copy of these analyses is included in Appendix J. The contents of these drums were found to be clean except for low levels of laboratory contamination and were approved by the MDEQ for surface spreading.

#### 4.8.3 Purge and Development Water and Decontamination Fluids

All waste waters from RI activities were containerized in two polyethylene tanks; one tank (550 gal) was used to contain decontamination fluids and the other tank (1100 gal) for development and purge water. The fluid content of each of the tanks were sampled separately for VOCs, TPH, SVOCs, and metals to determine their disposition. The analytical results were found to be within the acceptance criteria of the Cascade County Water and Sewer Department for disposal by slow discharge to the installation sanitary sewer system. A copy of the analytical results and associated correspondence for discharge is included in Appendix J. In addition, decontamination water and sediment from the bottom of the decontamination pad were containerized in two drums and both water and sediment sampled for the same parameters above.

Decontamination fluids came from two general sources: (1) decontaminated fluids (potable and ASTM Type I water and isopropanol) generated during the decontamination of stainless-steel split spoons, brass liners, measuring tapes, and other equipment associated with the soil and groundwater sampling and (2) potable water associated with the steam-cleaning of hollow-stem augers, bits, air hammers, etc. Water derived from these two sources was containerized in the same tank.

## **5. INVESTIGATION FINDINGS**

### **5.1 GEOLOGIC AND HYDROLOGIC INVESTIGATION RESULTS**

Information regarding the subsurface geology of the three sites is based on geologic logs recorded during the advancement of 14 soil borings and 10 monitoring wells during the 1996 investigation. Data from preexisting continuously cored monitoring wells drilled during the SI were incorporated.

Information pertaining to the hydrogeology of the IRP sites is based on groundwater level measurements obtained from both existing and newly installed wells and from hydraulic conductivities obtained from rising-head slug tests performed on seven of the ten RI installed wells.

#### **5.1.1 Geologic Investigation Result**

##### **5.1.1.1 Soil and Weathered Bedrock**

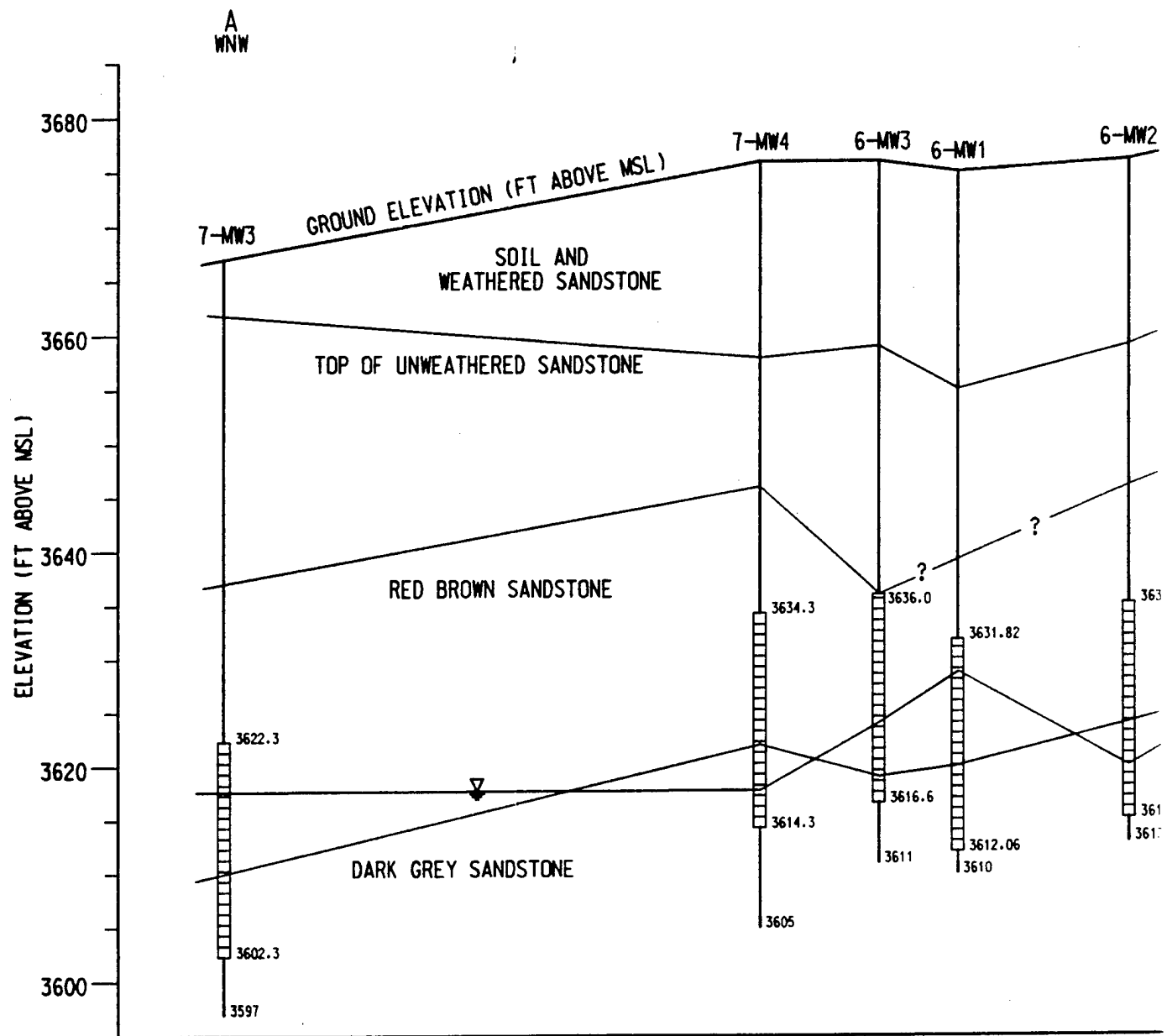
Information from the drilling of the 14 RI soil borings confirmed the presence of a weathered bedrock soil profile ranging in thickness from 2.5 ft to what may be as much as 20 ft. Penetration vs refusal with the hollow-stem augers was used as the determining factor in the depth to competent, unweathered bedrock. The ability to advance the split spoon sampler was not a valid indicator of the weathered/unweathered contact because penetration often stopped in the presence of rock fragments. The lithology of this interval was determined to be generally yellowish brown, very fine-grained to medium-grained sandstone with some silt and traces of clay. Occasionally interbeds of pale brown to light gray to pink sandstones and siltstones were reported present along with more coarse intervals with gravels. Soil boring logs from the RI borings are included as Appendix B. Descriptions of the lithology encountered refers to sands, but observations made from excavations to a depth of approximately 15 ft on the Base indicate weathered but bedded sandstones.

##### **5.1.1.2 Bedrock**

Unweathered, generally very-fine-grained sandstones with some siltstones were encountered down to 82.0 ft, the deepest well drilled (7MW-5). The bedrock section drilled was of low porosity and permeability as most wells did not initially "make water" and stood overnight before measurable amounts of water entered the borehole. Groundwater entry into the hole was attributed as much to entry through small fractures as to intergranular porosity. Continuous coring performed during the SI drilling confirmed the tight nature of the formation and the presence of numerous small fractures.

The lithology of the section drilled is relatively uniform in grain size and consists mainly of fine-grained sandstone. The only significant change identified from the air-drilled cuttings is an abrupt change from the upper, predominantly red-brown sandstone to a dark gray sandstone. Depth below ground surface of the color change varied but ranged from about 45 ft bgs to almost 60 ft bgs. These data are presented in interpretative geologic cross sections, Figs. 5.1 and 5.2. In general the change into the dark gray sandstone was accompanied by an increase in moisture of the cuttings.





LEGEND

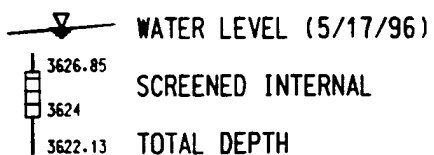
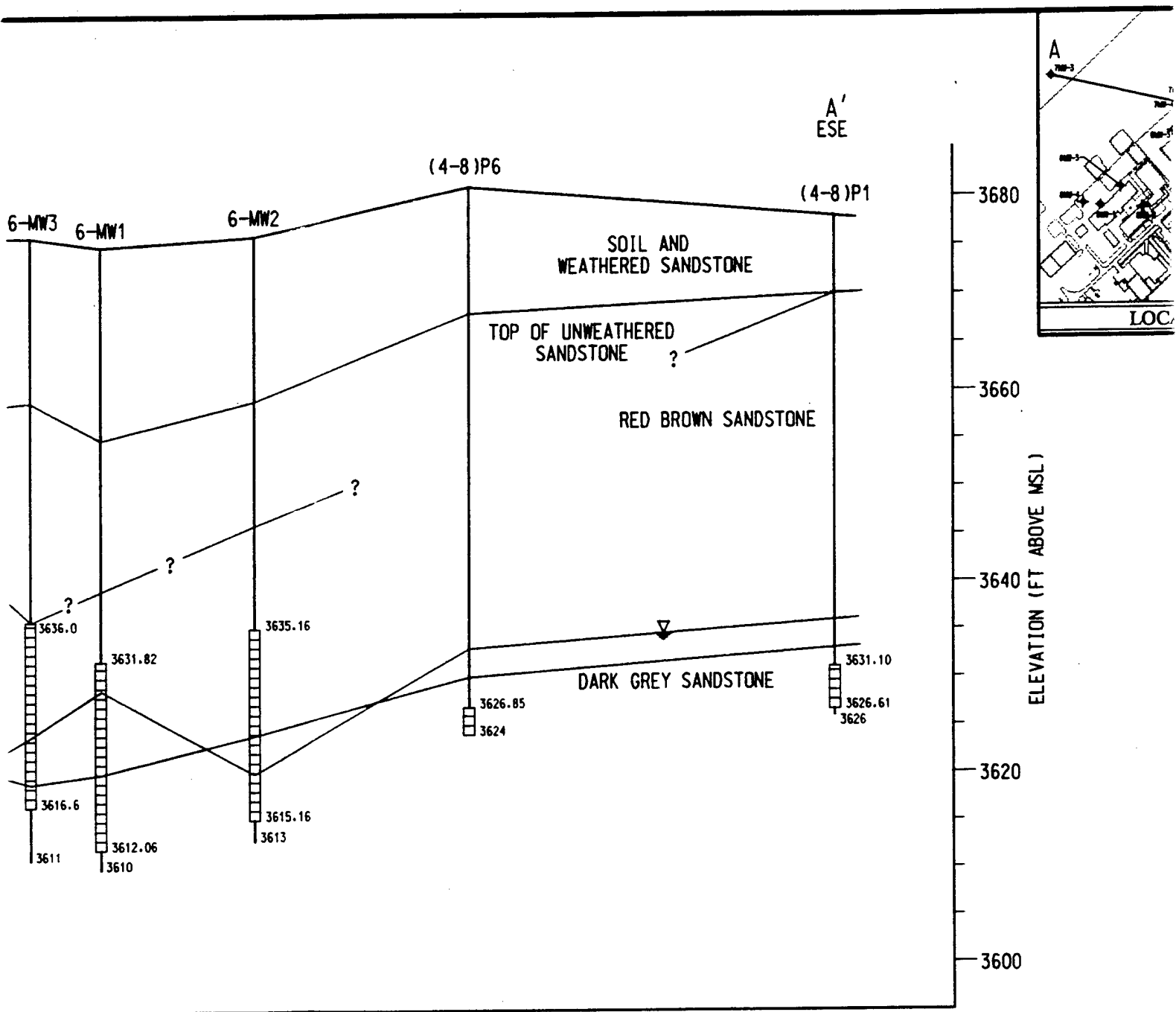
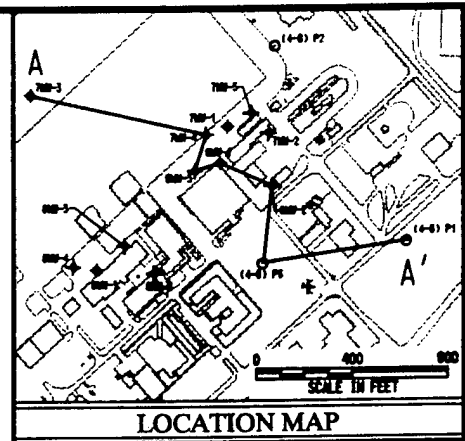
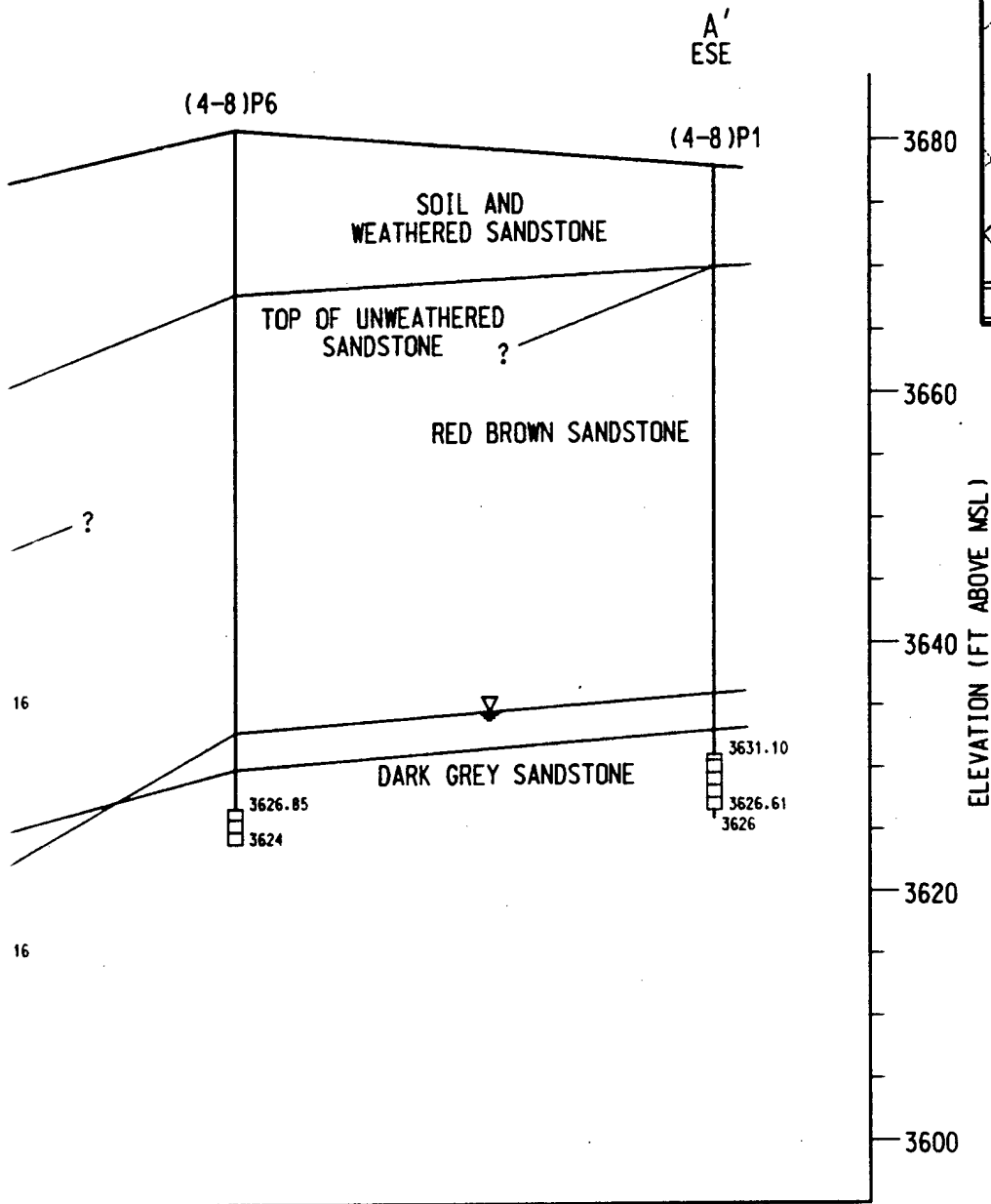


Fig. 5.1. Interpretive Geologic Cross Section A-A'. 1.



Geologic Cross Section A-A'. 120 FW Montana Air National Guard, Great Falls Montana.

2



0 200 400  
HORIZONTAL SCALE IN FEET

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FW Montana Air National Guard, Great Falls Montana.

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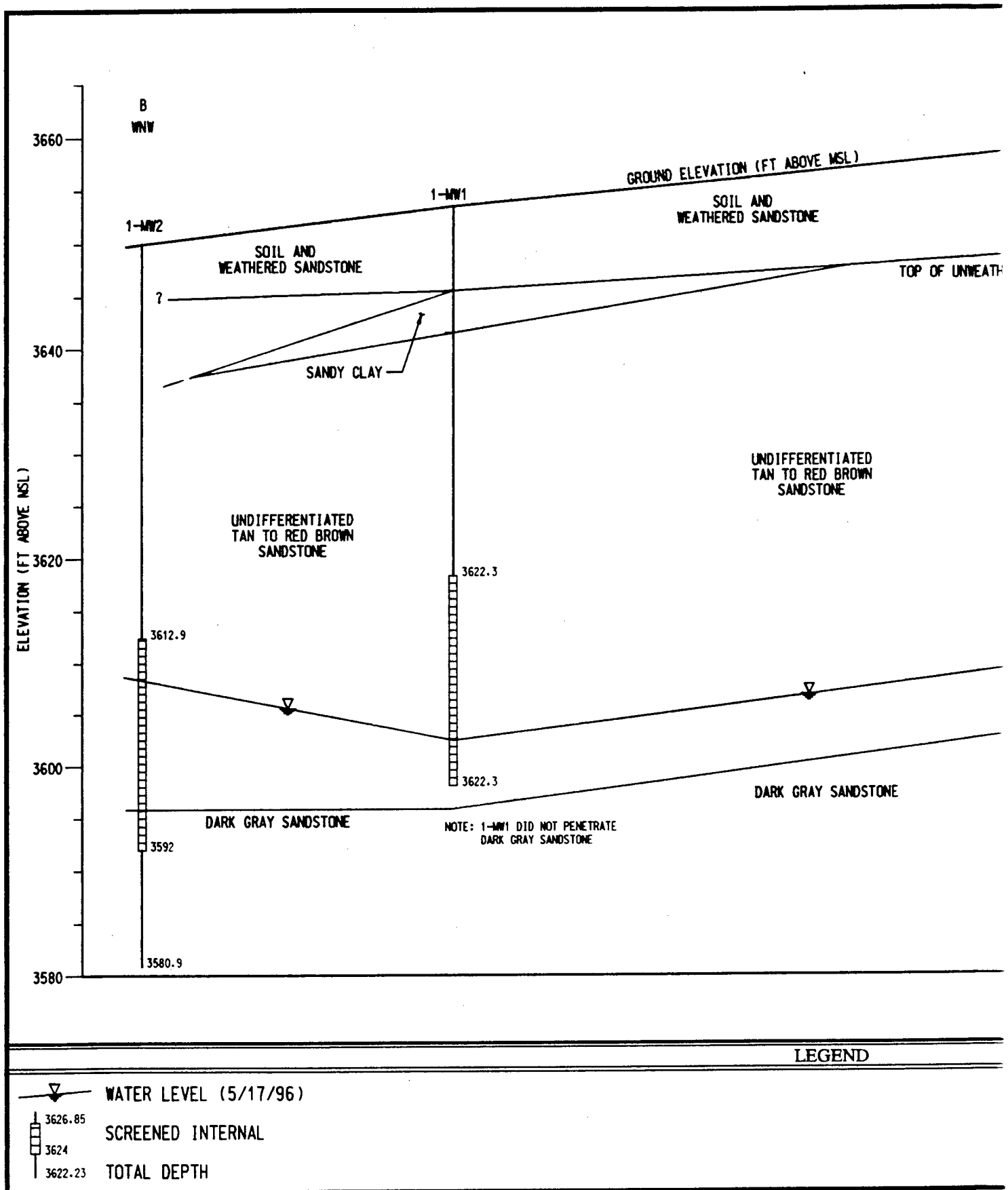
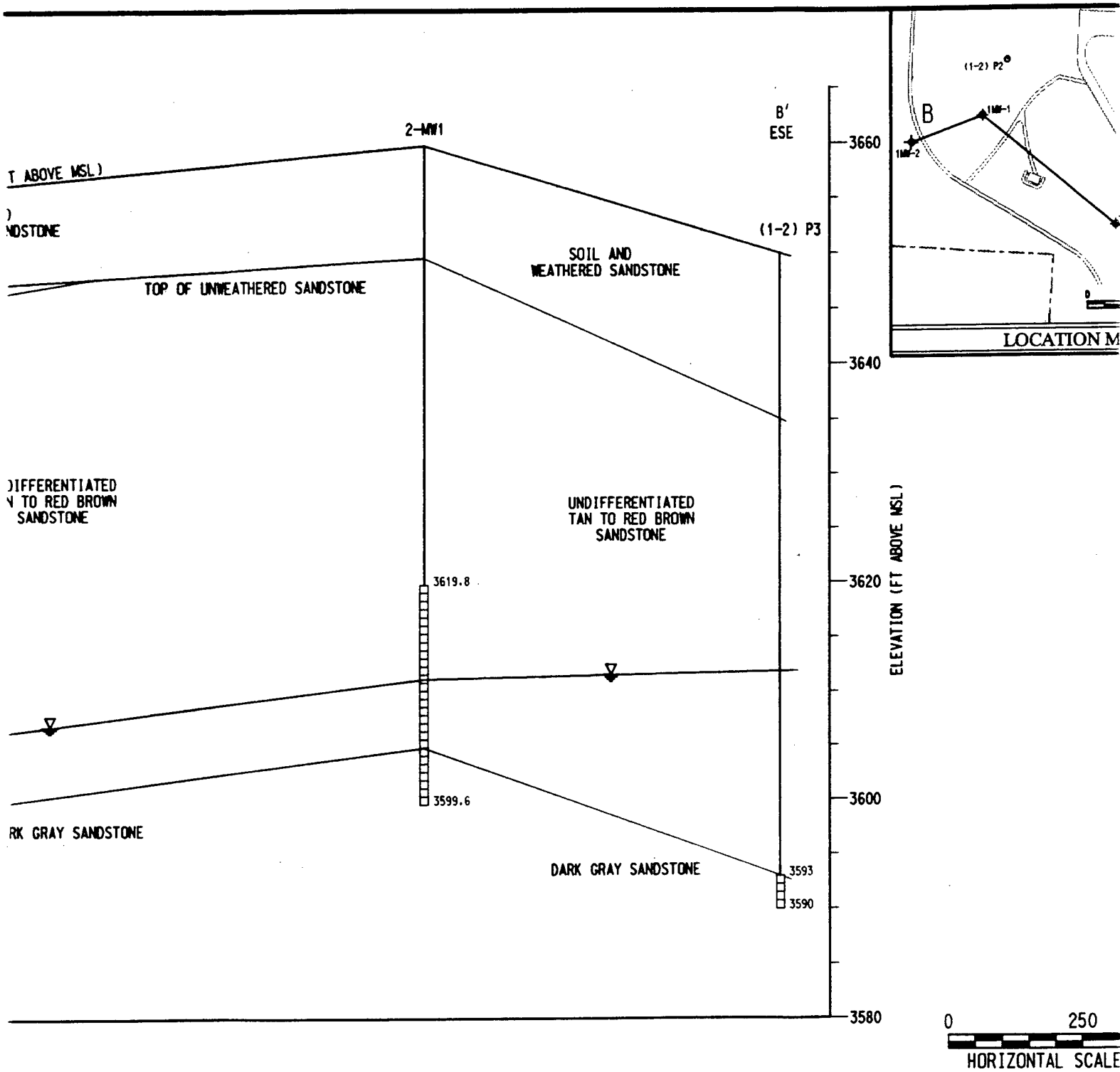
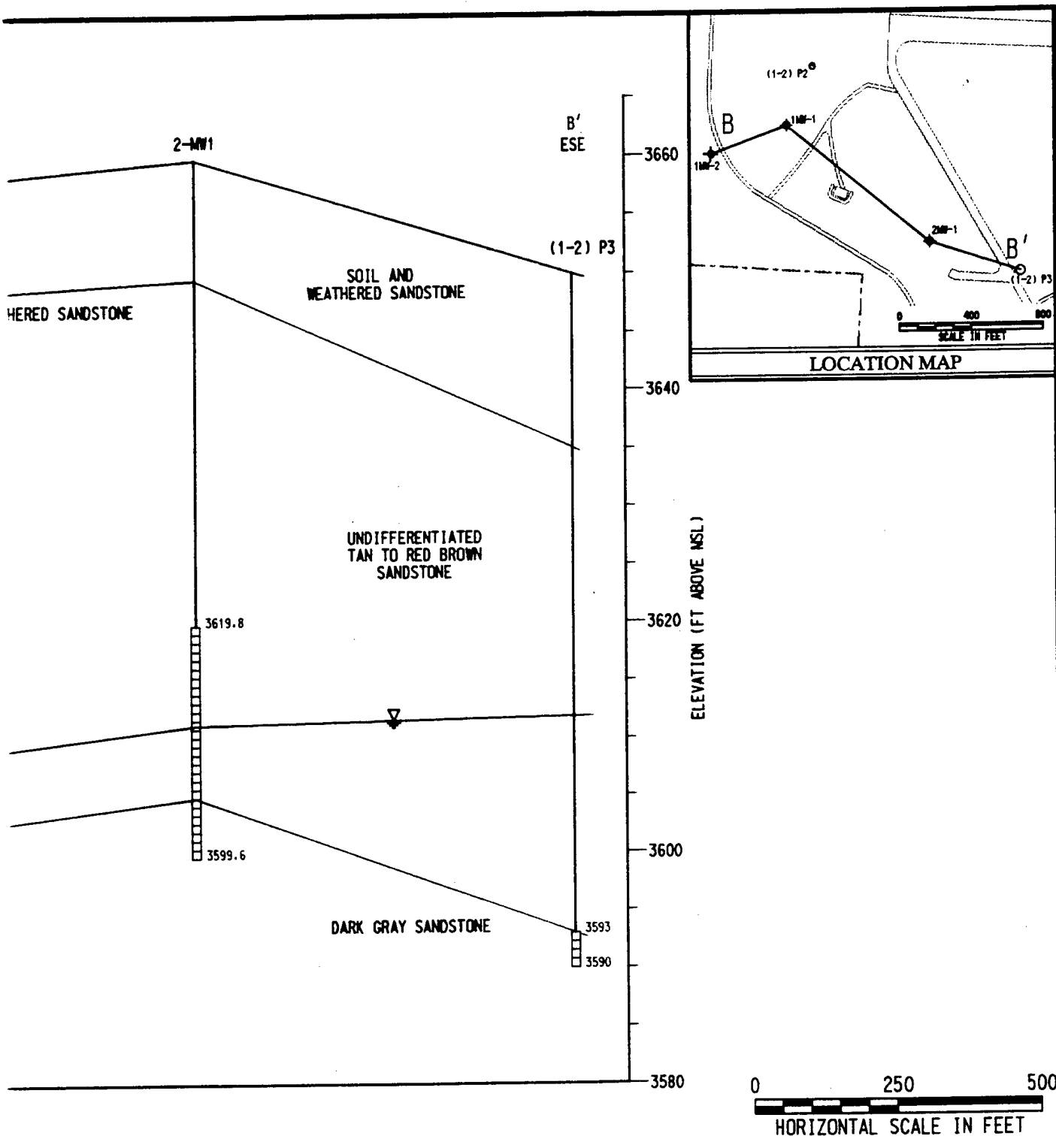


Fig. 5.2. Interpretive Geologic Cross Section B-B', 120 FW



Geological Cross Section B-B', 120 FW Montana Air National Guard, Great Falls Montana.



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Considerations discussed below indicate porosity and permeability variations in the bedrock aquifer may markedly affect local groundwater flow patterns.

## **5.1.2 Hydrologic Investigation Results**

### **5.1.2.1 Potentiometric Maps**

Figures 5.3 and 5.4 present potentiometric maps for Site 1 and the area of Sites 6, 7, and 8 based on groundwater elevation data collected in April 1996. Groundwater elevation data from the May 1995 measurement are posted but not contoured (Fig. 5.4). The elevation data are presented in Table 5.1. Along with the maps in the SI report, these maps were used to identify the downgradient locations of monitoring wells before their drilling. At Site 1, two interpretations were used in an effort to locate 1MW-2 in a downgradient position to the area of past contamination. Both interpretations are shown on Fig. 5.3. In one interpretation, water-level information from 1MW-1 was considered anomalous and, in contouring, the data point was ignored. In the other interpretation, the well data at 1MW-1, although causing an increase in hydraulic gradient in the immediate vicinity of the well, were honored. Both interpretations, however, demonstrate a westward groundwater flow and may be equally valid. At Sites 6, 7, and 8 (Fig. 5.4), before the RI drilling, a fairly uniform northwestward groundwater flow that swings to the west in the vicinity of Site 7 is depicted.

The Basewide interpretation for the RI report of the groundwater flow pertaining to Sites 1, 6, 7, and 8 are based on two rounds of groundwater elevation measurements. The groundwater data from 19 monitoring wells and 10 piezometers are presented in Table 5.2. Potentiometric maps of the groundwater data for Sites 6, 7, and 8 from May 1996 and July 1996 are presented in Figs. 5.5 and 5.6, respectively. The incorporation of these data and the resulting contouring presents a somewhat more complex interpretation to groundwater flow than what was considered from the SI report. This is also true for the water-level map prepared from the April 1996 data. Similarly, the groundwater flow pattern developed after the drilling of 1MW-2 is altered from that considered from the SI and water levels measured preceding the RI activities. Figure 5.7 depicts the groundwater flow direction at Site 1.

### **5.1.2.2 Anomalies in Groundwater Flow**

Two anomalies in the groundwater flow patterns were found to exist: an apparent reversal or uncertain flow direction at Site 1 and a water-level elevation encountered significantly higher in 6MW-1 relative to 6MW-2. The 6MW-1 water level elevation causes a reversal of flow direction from that originally anticipated at Site 6.

As evidenced in the SI report, monitoring well 1MW-1 does not penetrate the dark grey sandstone found in the adjacent wells and piezometers. This lower sequence encountered in 1MW-2 and adjacent wells at Site 1—as well as those drilled at Sites 6, 7, and 8—is considered to be the shallowest and most consistent water-bearing interval in the unweathered sandstone sequence beneath the Base. Because 1MW-1 did not penetrate this unit, its water level data represent a different aquifer. Because 1-MW 1 did not penetrate this unit, its water level data represent a different aquifer. Although it can be contoured with data from the surrounding wells, an anomalously steep hydraulic gradient results.

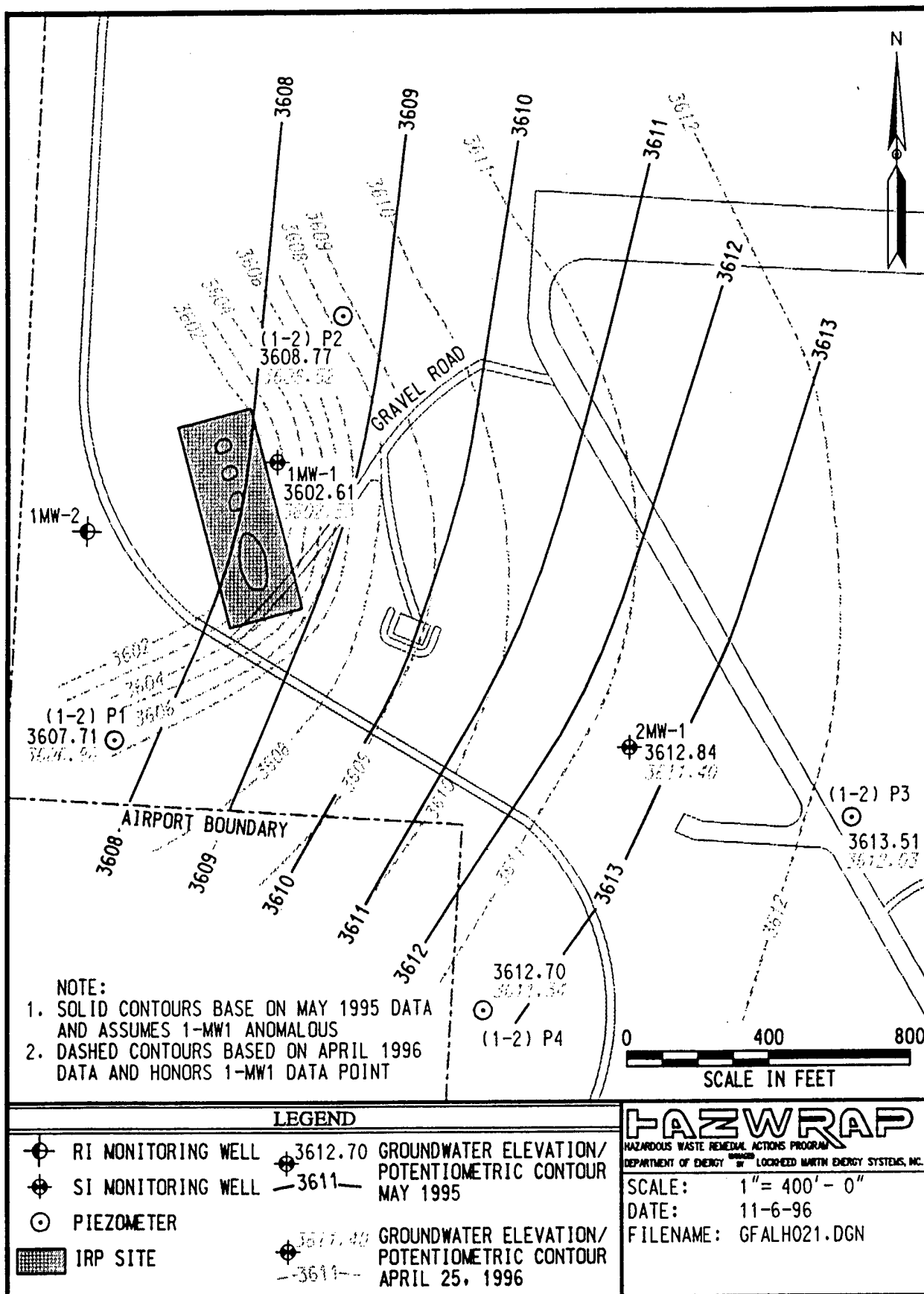


Fig. 5.3. Site 1 Monitoring Well Location and Ground Water Flow Map.  
120th FW Montana Air National Guard, Great Falls, Montana.



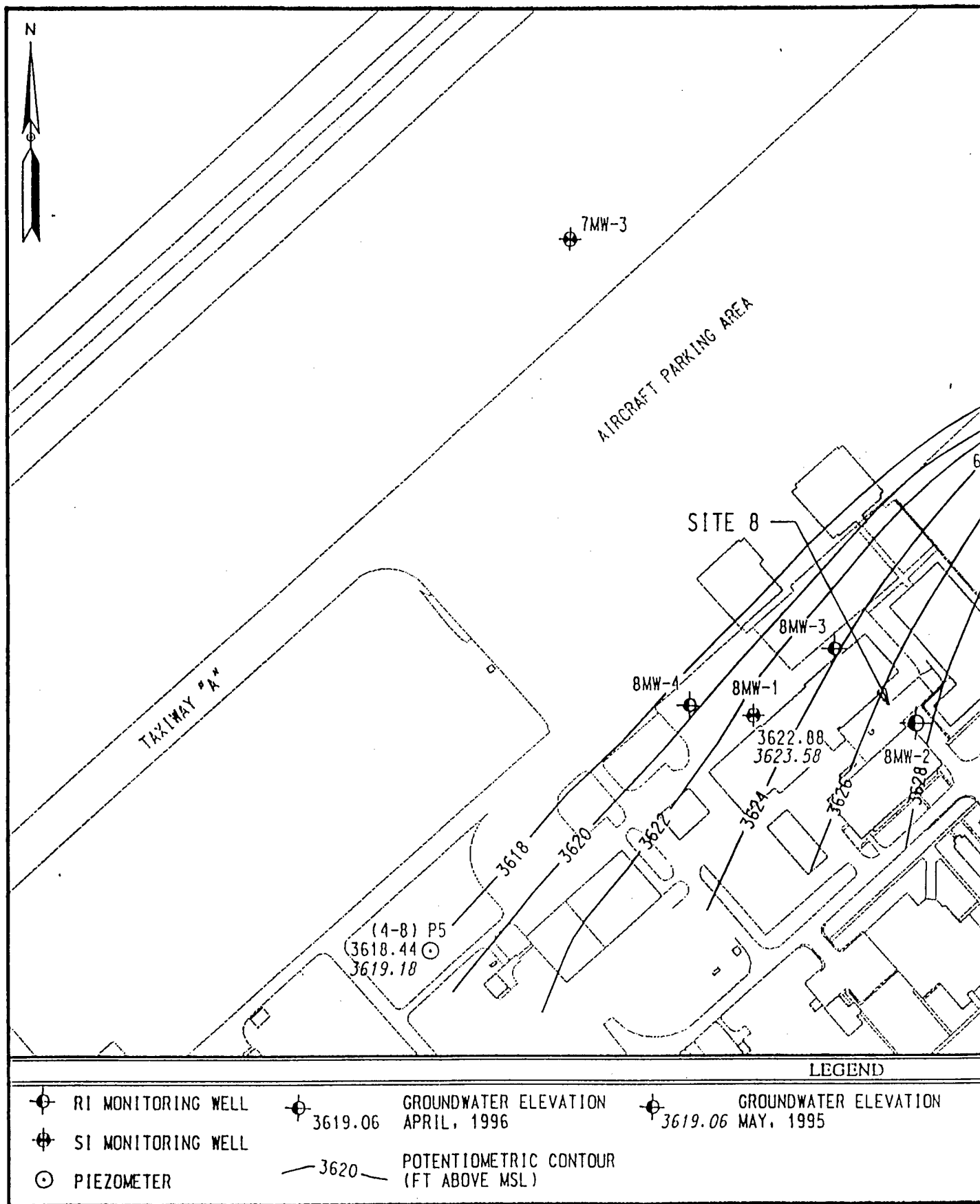
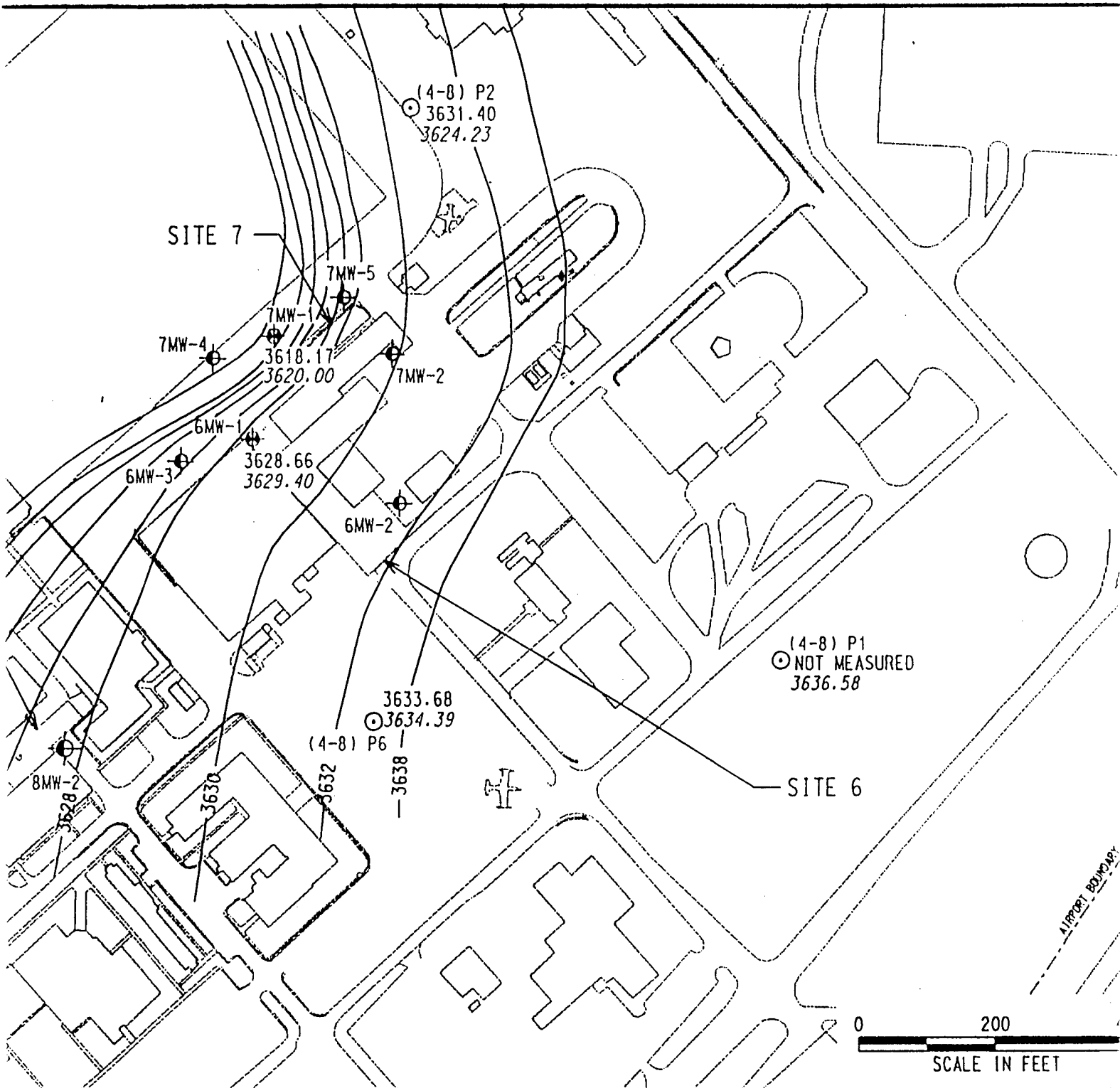
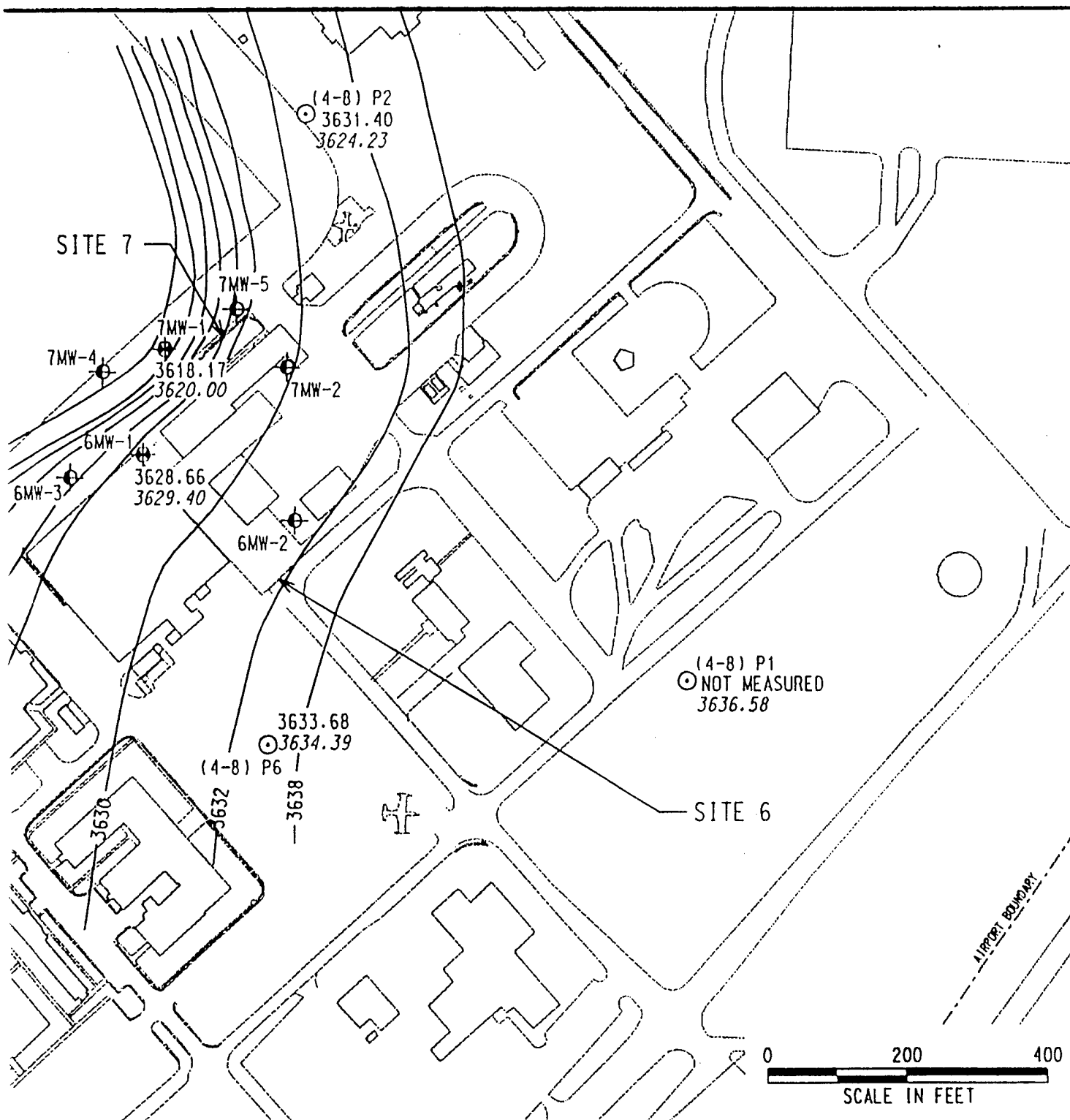


Fig. 5.4. Groundwater Potentiometric Contour Map - April, 19



ND	<b>HAZWRA</b>
ELEVATION	HAZARDOUS WASTE REMEDIAL ACTIONS PROGRAM DEPARTMENT OF ENERGY
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HAZARDOUS WASTE REMEDIAL ACTIONS PROGRAM  
DEPARTMENT OF ENERGY GA-0013 WORTH MARETTA ENERGY SYSTEMS, INC.

SCALE: 1" = 200' - 0"  
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**Table 5.1 Groundwater Elevation Data - April 1996 and May 1995 - 121st FW, Montana Air National Guard, Great Falls, Montana**

Monitoring Well/ Piezometer No.	TOC Elevation (MSL)	Depth to Water 4/24/96	Groundwater Elevation (MSL)	TOC Elevation (MSL)	Depth to Water 5/ /95	Groundwater Elevation (MSL)
(1-2)P1	3651.78	44.82	3606.96	3651.78	44.07	3607.71
(1-2)P2	3654.55	46.03	3608.52	3654.55	45.78	3608.52
(1-2)P3	3659.89	47.86	3612.03	3659.89	46.38	3613.51
(1-2)P4	3660.39	49.05	3611.34	3660.39	47.69	3612.70
1MW-1	3656.35	53.82	3602.53	3656.35	53.74	3602.61
2MW-1	3658.52	47.12	3611.40	3658.52	45.68	3612.84
(4-8)P1	3679.47			3679.47	42.89	3636.58
(4-8)P2	3675.58	44.18	3631.40	3675.58	40.97	3634.61
(4-8)P3	3672.77	51.37	3621.4	3672.77	48.54	3624.23
(4-8)P4	3665.21	46.67	3618.54	3665.21	45.80	3619.41
(4-8)P5	3672.82	54.38	3618.44	3672.82	52.84	3619.98
(4-8)P6	3677.55	43.87	3633.68	3677.55	43.16	3634.39
4MW-1	3669.24	50.81	3618.43	3669.24	50.26	3618.98
5MW-1	3667.82			3667.82	46.71	3621.11
6MW-1	3676.06	47.40	3628.66	3676.06	46.66	3629.40
7MW-1	3675.03	56.86**	3618.17	3675.03	54.81	3620.22
8MW-1	3675.78	52.90	3622.88	3675.78	52.20	3623.58
BGMW-1	3677.41			3677.41	42.08	3635.33

\*\* = True water levels = apparent water level - specific gravity JP4 x apparent thickness free product

$$T = 57.75 - 0.81 \times 1.10 = 56.86$$

4/16/96 Top Water 57.75

Top Product 56.65

1.10

**Table 5.2 Groundwater Elevation Data - May and July 1996 - 121st FW, Montana Air National Guard, Great Falls Montana**

Monitoring Well/ Piezometer No.	TOC Elevation (MSL)	Depth to Water 5/16-17/96	Groundwater Elevation ( MSL)	Depth to Water 7/7/96	Groundwater Elevation (MSL)
6MW-1	3676.52*	47.69	3628.83	48.00	3628.52
6MW-2	3675.86	55.49	3620.37	54.50	3621.36
6MW-3	3676.32	52.24	3624.08	52.04	3624.28
7MW-1	3675.45*			54.48**	3620.97
7MW-2	3676.21	54.86	3621.35	53.45	3622.76
7MW-3	3667.82	50.12	3617.7	50.00	3617.82
7MW-4	3675.98	58.08	3617.9	57.73	3618.25
7MW-5	3675.55	54.59	3620.96	53.14	3622.41
8MW-1	3675.78^	52.80	3622.98	52.86	3622.92
8MW-2	3675.64	55.28	3620.36	51.56	3624.08
8MW-3	3675.66	51.80	3623.86	51.20	3624.46
8MW-4	3674.68	53.63	3621.05	53.74	3620.94
1MW-1	3654.48*	53.87	3600.61	53.65	3600.83
1MW-2	3652.69	44.35	3608.34	43.46	3609.23
2MW-1	3656.93*	47.29	3609.64	46.08	3610.85
4MW-1	3669.24^	50.76	3618.48	50.59	3618.65
5MW-1	3667.82^	50.35	3617.47	48.84	3618.98
BGMW-1	3677.41^	45.28	3632.13	44.81	3632.60
(1-2) P1	3651.78^	44.97	3606.81	44.34	3607.44
(1-2) P2	3654.55^	46.04	3608.51	45.85	3608.70
(1-2) P3	3659.89^	48.04	3611.85	46.82	3613.07
(1-2) P4	3660.39^	49.21	3611.18	48.06	3612.33
(4-8) P1	3679.47^	43.53	3635.94	43.55	3635.92
(4-8) P2	3675.58^	42.10	3633.48	41.00	3634.58
(4-8) P3	3672.77^	52.06	3620.71	51.42	3621.35
(4-8) P4	3665.21^	46.92	3618.29	46.34	3618.87
(4-8) P5	3672.82^	55.40	3617.42	53.76	3619.06
(4-8) P6	3677.55^	44.29	3633.26	44.40	3633.15
* = Surveyors note indicates measured to brass cap					
^ = Elevation as per letter HAZWRAP dated 12/12/92					
** = True water level = apparent water level - specific gravity JP4 x apparent thickness free product					
T = 54.60 - 0.81 x 0.15 = 54.48					
T = 58.49 - 0.81 x 1.32 = 57.42					
7/17/96 Top Water 54.60			5/13/96 Top Water 58.49		
Top Product 54.45			Top Product 57.17		
0.15			1.32		

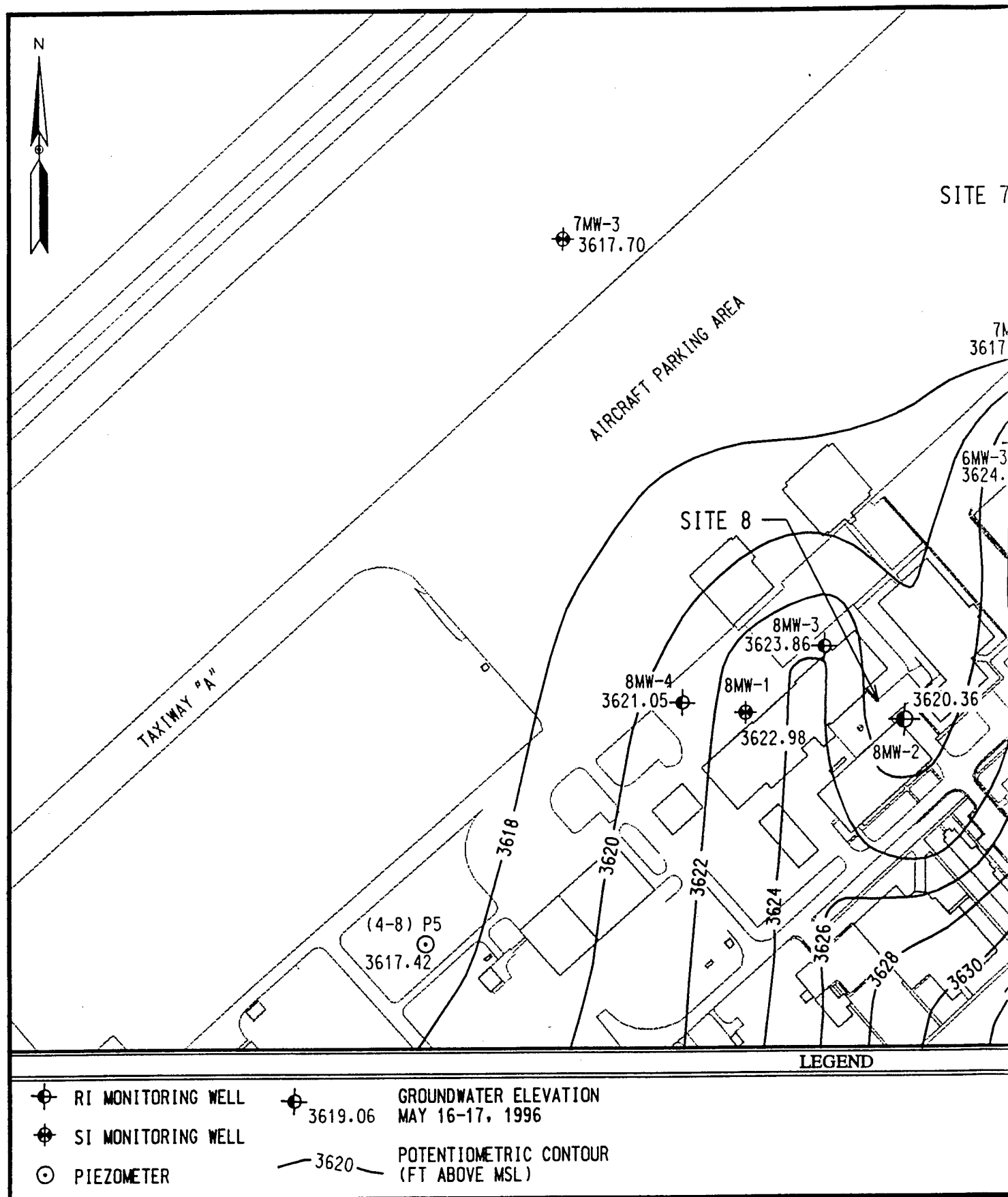
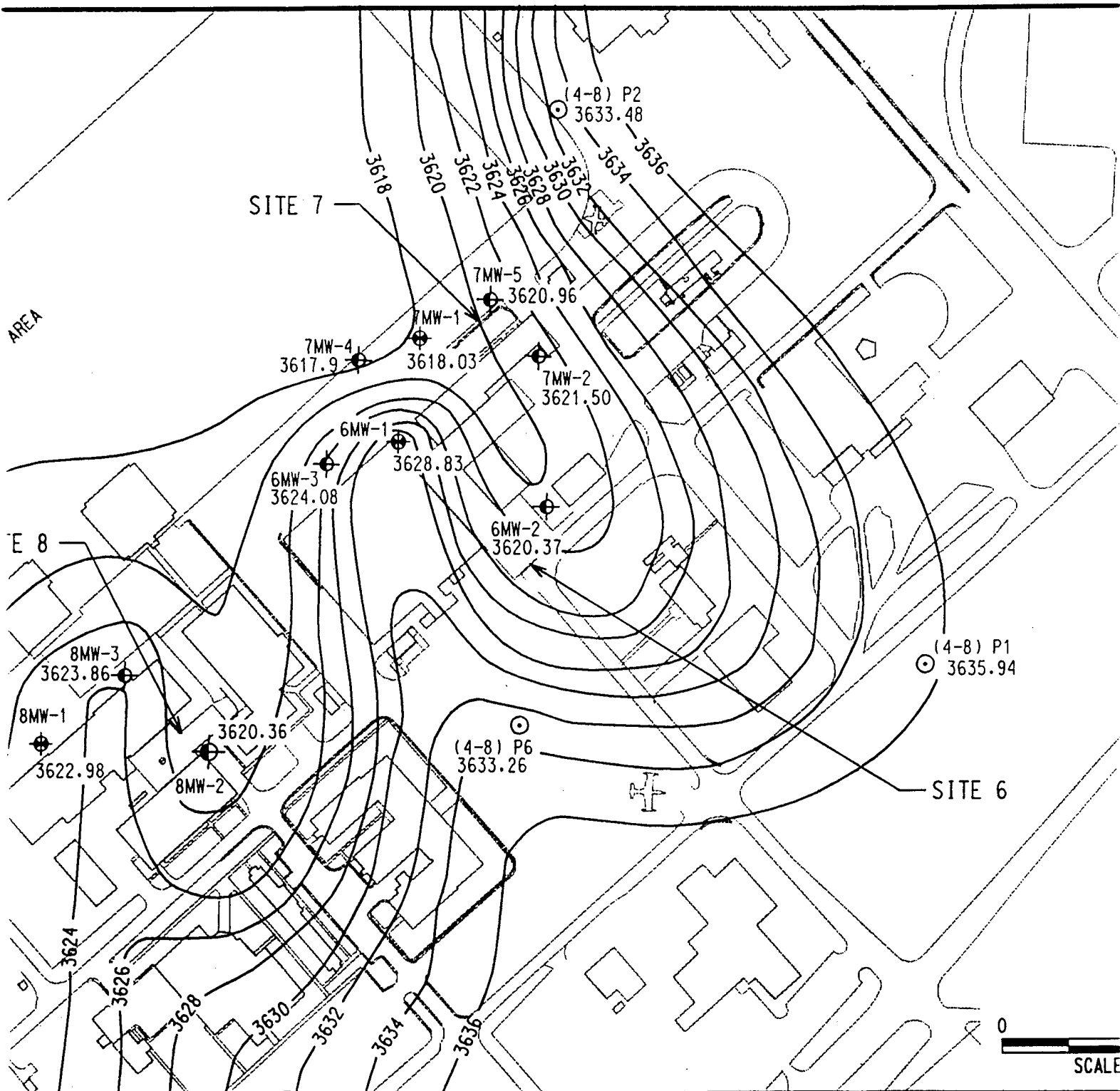


Fig. 5.5. Groundwater Potentiometric Contour Map - May, 1996. 1



LEGEND

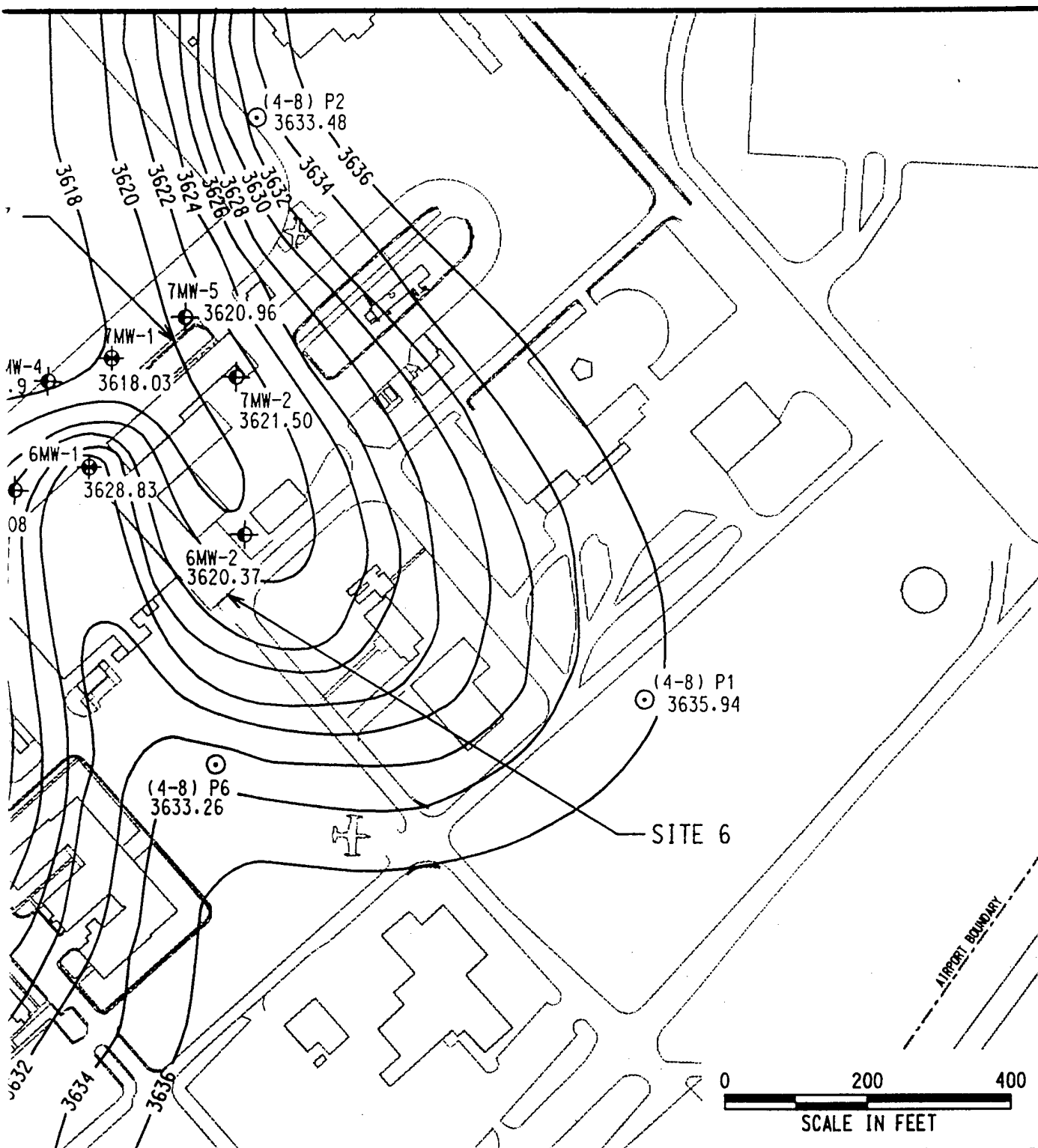
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**HAZ**  
HAZARDOUS WASTE REMEDIATION  
DEPARTMENT OF ENERGY

SCALE:  
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FILENAME:

etric Contour Map - May, 1996. 120 FW Montana Air National Guard, Great Falls Montana.

2



**HAZWARP**

HAZARDOUS WASTE REMEDIAL ACTIONS PROGRAM  
DEPARTMENT OF ENERGY UNDER MARTIN MARETTA ENERGY SYSTEMS, INC.

SCALE: 1" = 200' - 0"

DATE: 02-06-97

FILENAME: GFALH036.DGN

20 FW Montana Air National Guard, Great Falls Montana.

3



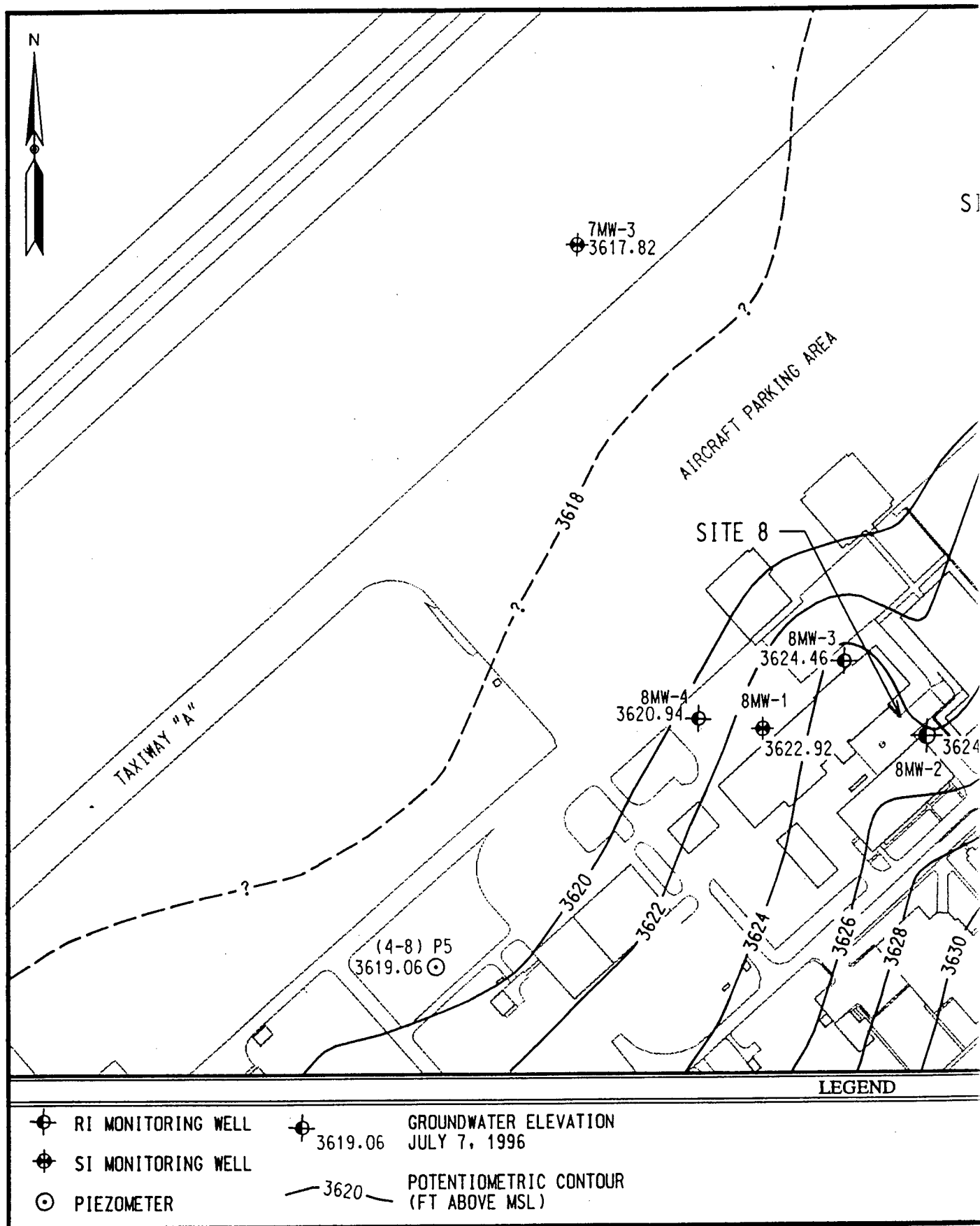
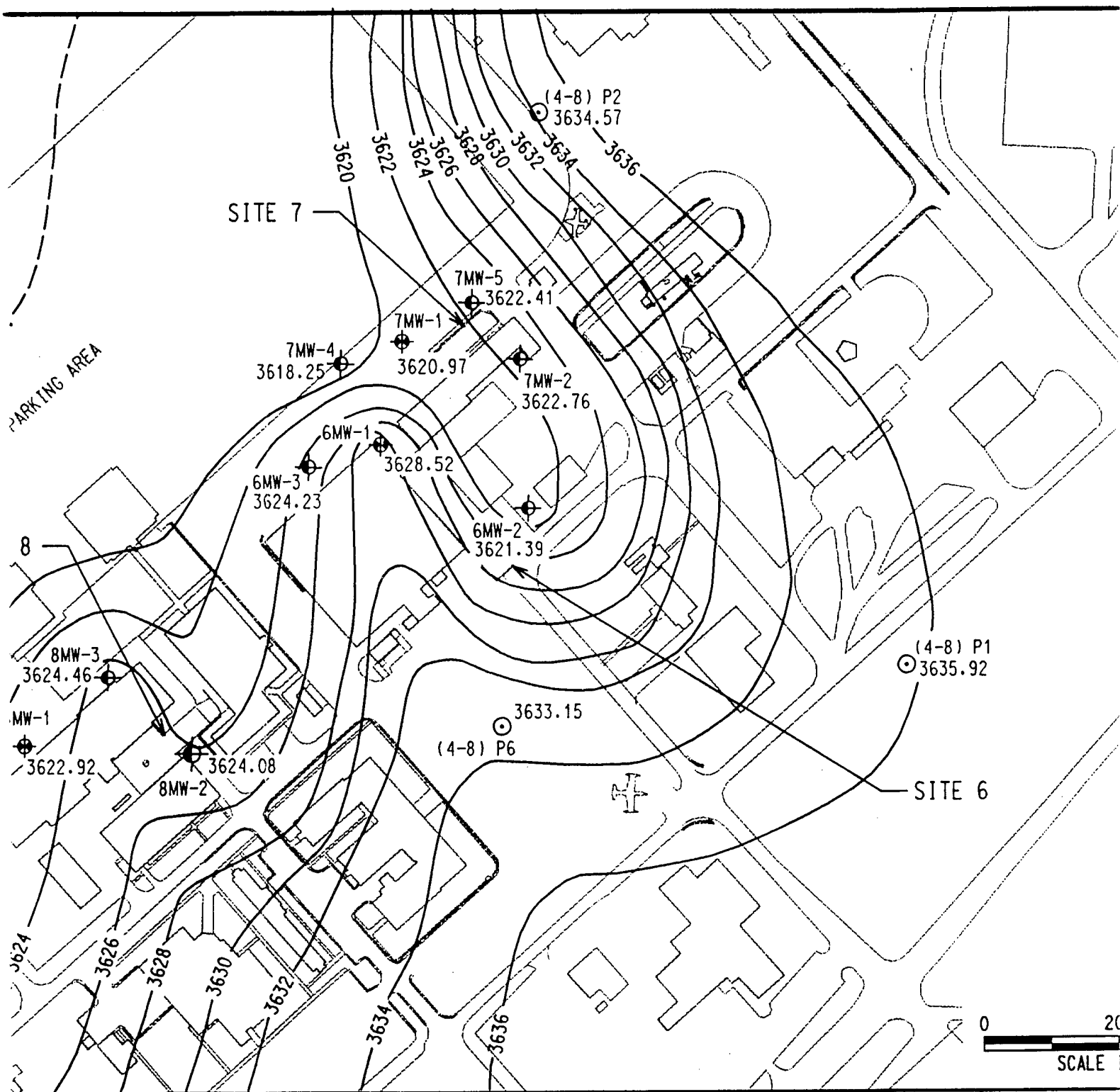


Fig. 5.6. Groundwater Potentiometric Contour Map - July, 1996



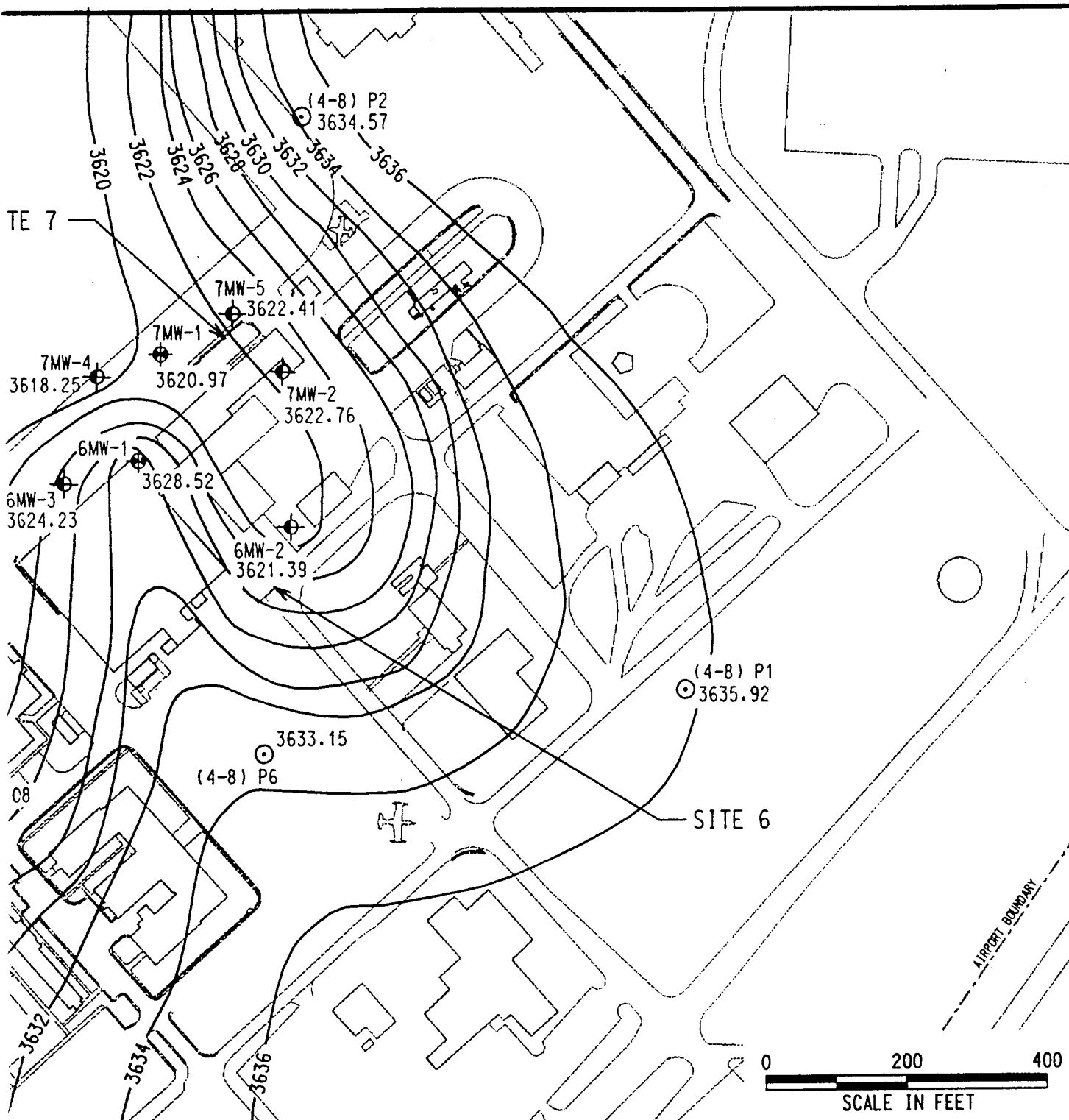
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**HAZV**  
HAZARDOUS WASTE REMEDIAL ACTION  
DEPARTMENT OF ENERGY

SCALE:  
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FILENAME:

tric Contour Map - July, 1996. 120 FW Montana Air National Guard, Great Falls Montana.



**HAZWOP**  
HAZARDOUS WASTE REMEDIAL ACTIONS PROGRAM  
DEPARTMENT OF ENERGY WORTH WORTH MARKET ENERGY SYSTEMS, INC.

SCALE: 1" = 200' - 0"  
DATE: 02-06-97  
FILENAME: GFALH018.DGN

996. 120 FW Montana Air National Guard, Great Falls Montana.

3

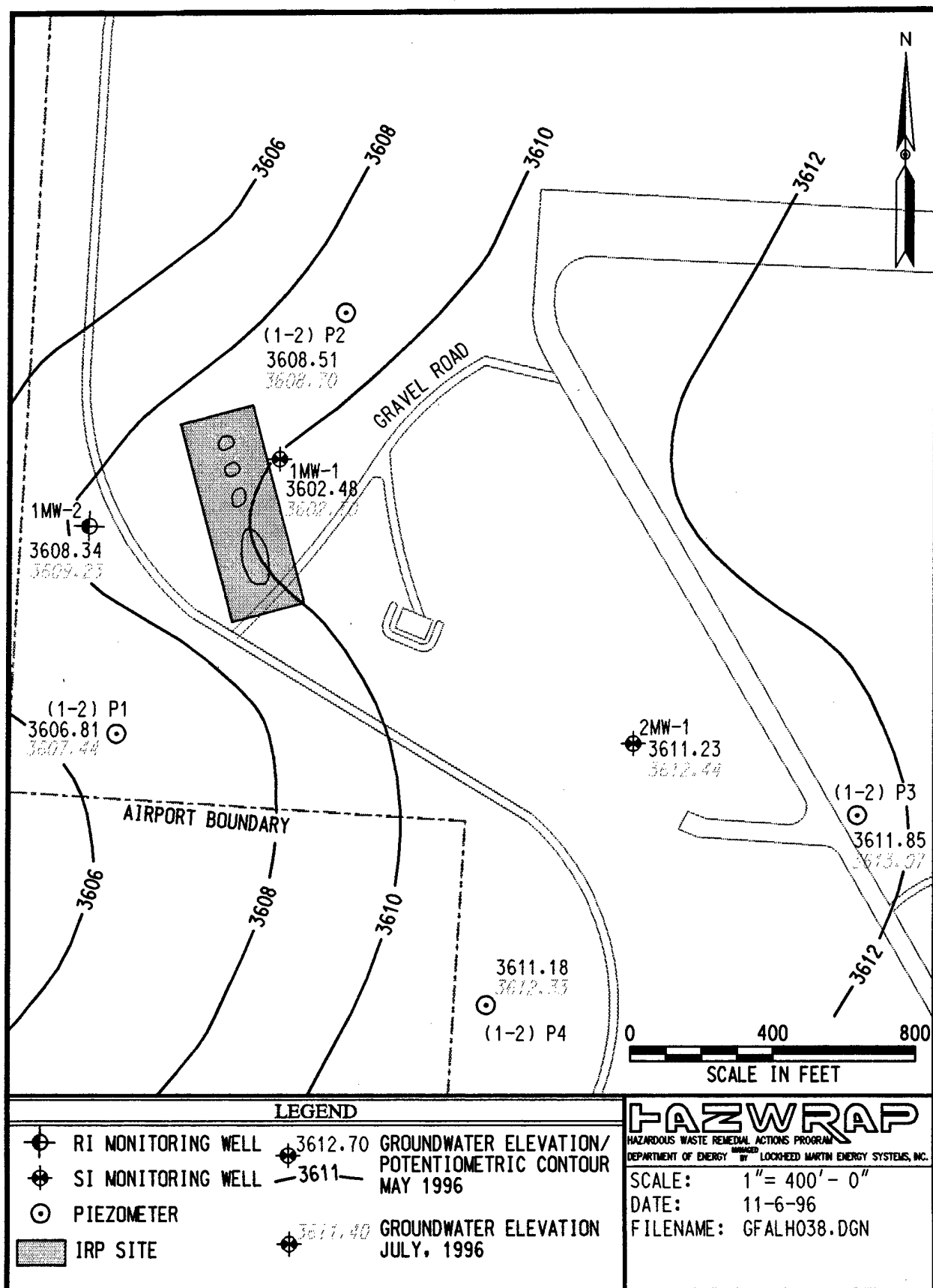


Fig. 5.7. Site 1 Groundwater Potentiometric Contour Map, May, 1996.  
 120th FW Montana Air National Guard, Great Falls, Montana.

At Site 6, lithologic descriptions of the rock cores taken during the drilling of 6MW-1 indicate a very hard, well-indurated sandstone sequence with siliceous cement toward the bottom of the hole drilled. In addition, the bottom 10 ft of section penetrated had shale laminae throughout. It is suggested that these "tight" conditions may anomalously affect the water-level elevation measured.

### 5.1.2.3 Hydraulic Conductivity Testing

In situ hydraulic conductivity testing was conducted on seven of the ten monitoring wells installed at the three sites during the RI. Test results are included in Appendix H. Although both falling-head (injection of the slug) and rising-head (withdrawal of the slug) were performed, only the rising-head test data were analyzed by the Bouwer and Rice method (Bouwer and Rice 1976) to calculate the hydraulic conductivity because the monitoring wells were screened in unconfined conditions. Hydraulic conductivities for the aquifer ranged from 1.03E-2 ft/min to 9.62E-3 ft/min over the three sites (Table 5.3). The average hydraulic conductivity for the sites was calculated at 2.38E-2 ft/min. Hydraulic conductivities appear to be higher than anticipated. The results may more closely reflect the fractured nature of the rock instead of its matrix permeability and porosity. Fractures were commonly reported in the cores obtained during the SI drilling.

Average linear velocity for groundwater for the overall Sites 6, 7, and 8 area can be estimated from hydraulic conductivity (K), horizontal hydraulic gradient (i), and porosity (n) using the following equation:

$$\text{Average linear velocity} = \frac{K(i)}{n}$$

Because of the apparent change in gradient over the extent of the three sites, determination of the horizontal gradient varies. At Site 8, a value of 0.02 is representative while at Sites 6 and 7 steeper gradients of up to 0.047 may be considered. The average porosity determined from eight soil boring samples was calculated to be 27.9% (Appendix G). Although obtained for the weathered bedrock soil samples, the value is considered a conservative percent porosity value to use in the velocity calculation. Using the average hydraulic conductivity obtained from the slug tests (and depending on the steepness of the gradient), average linear velocity may range from around 2.43 ft/day at Site 8 to as much as 5.58 ft/day at Sites 6 and 7.

## 5.2 BACKGROUND RESULTS

Three background soil borings and one background monitoring well were installed during the SI to determine background soil and water concentrations at the Base. (The generalized locations of the borings and the monitoring well are shown on Fig. 2.2). The background samples were collected in an area that reportedly was never used for waste management activities and at which groundwater was upgradient to any of the sites investigated by the SI and RI. Two soil samples were collected from each of the borings and two rounds of groundwater samples collected from the monitoring well.

**Table 5.3**  
**Slug Test Results, IRP Sites No. 6, No. 7, and No. 8**  
**120th Fighter Wing, Montana ANGB, Great Falls, Montana**

Monitor Well	Hydraulic Conductivity (ft/min)	Hydraulic Conductivity gpd/ft <sup>2</sup>
<b>IRP Site No. 6</b>		
6MW-2	2.89 X 10 <sup>-2</sup>	311
6MW-3	1.87 X 10 <sup>-2</sup>	201
<b>IRP Site No. 7</b>		
7MW-2	4.27 X 10 <sup>-2</sup>	460
7MW-3	1.03 X 10 <sup>-2</sup>	111
7MW-5	2.04 X 10 <sup>-2</sup>	220
<b>IRP Site No. 8</b>		
8MW-2	1.01 X 10 <sup>-2</sup>	109
8MW-4	9.62 X 10 <sup>-3</sup>	104

ft/min - feet per minute

gpd/ft<sup>2</sup> - gallons per day per square foot

The results of the CLP analyses on the background soil samples are presented in Table 5.4. Only two organic compounds were detected in one of the three borings: acetone at 160  $\mu\text{g/kg}$  and toluene at 10  $\mu\text{g/kg}$ . Acetone is a common laboratory and sampling contamination.

A number of metals were detected in the soils at the range of concentrations shown below. The average range of concentrations of these metals in soils in the western United States (Shacklette 1984) is also shown.

	Range of concentrations in background soils (mg/kg)	Range of concentrations in western United States (mg/kg)
Antimony	ND	<1-2.6
Arsenic	4.3-9.6	<0.10-9
Barium	101-971	70-5,000
Beryllium	ND	<1-15
Cadmium	ND	0.01-0.7
Chromium	12.9-20.7	3-2,000
Copper	6.9-18.6	2-300
Lead	5.5-12.2	<10-700
Nickel	6.4-14.8	<5-700
Selenium	ND-0.43	<0.1-4.3
Zinc	30.4-54.7	10-2,100
Thallium	ND	2.4-31
Mercury	ND	<0.01-4.6

ND = nondetect.

Average concentrations and the standard deviations of the background soil results were calculated and are included on Table 5.4. These values, along with the range associated with the average and two standard deviations, are also presented. If the background concentrations follow a normal distribution, the average plus two standard deviations will include 95.4% of the values. For the purpose of this investigation, two standard deviations are used as the background range in soil for all parameters. Any organics detected in groundwater will be considered above background. Background levels for metals in groundwater will be less than or equal to the highest levels detected in background samples.

The results of the groundwater analyses from the background monitoring well are shown in Table 5.5. No organic compounds were detected. Four metals were detected in the first round of sampling: arsenic (1.1  $\mu\text{g/L}$ ), barium (56  $\mu\text{g/L}$ ), lead (4.9  $\mu\text{g/L}$ ), and zinc (15  $\mu\text{g/L}$ ). In the second round three metals were detected: barium (62.2  $\mu\text{g/L}$ ), lead (4.3  $\mu\text{g/L}$ ), and zinc (9.8  $\mu\text{g/L}$ ). All these metals were reported in a blank associated with the sampling program. The TPH concentration reported in the background well was 1 mg/L.

Table 5.4 Chemical Constituents Detected in Soil, Background - Site Investigation, 1992  
(CLP Laboratory Analysis)

Chemical	MANG-BG SB1-1	MANG-BG SB1-3.5	MANG-BG SB2-1	MANG-BG SB2-3	MANG-BG SB3-1	MANG-BG SB3-3.5	Average	Standard Deviation	Average +/- Two Standard Deviations	Average +/- Three Standard Deviations
Volatile organics (µg/kg)										
Acetone	ND	ND	ND	ND	ND	160	27	65	ND - 157	ND - 222
Toluene	ND	ND	ND	ND	10	ND	2	4	ND - 9.0	ND - 15
BNA organics (µg/kg)	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA
Metals (mg/kg)										
Arsenic	5.2	9.6	6.1	4.3	4.3	6.1	5.9	2.0	1.9 - 9.9	ND - 11.9
Barium	219	971	101	206	171	919	431	400	ND - 1231	ND - 1631
Chromium	13.3	14.4	13.3	20.7	19.6	12.9	15.7	3.5	8.7 - 22.7	5.2 - 26.2
Copper	10.8 *	18.6 *	6.9 *	12.8 *	11.1 *	8.5 *	11.5	4.1	8.7 - 19.7	ND - 23.8
Lead	8.2	8.7	5.5 B	12.2	8.3	6	8.2	2.4	3.4 - 13	1.0 - 15.4
Nickel	10	14.4	6.4 B	14.8	10.5	7.4	10.6	3.5	3.6 - 17.6	0.1 - 21.1
Selenium	0.37 BW	ND	ND	0.32 BW	0.43 BW	0.42 BW	0.26	0.20	ND - 0.66	ND - 0.86
Zinc	34.3 *	54.7 *	33.3 *	48 *	47.4 *	30.4 *	41.4	9.9	21.6 - 61.3	11.7 - 71.2
Total petroleum hydrocarbons (mg/kg)	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA

ND = not detected. NA = not applicable

Data qualifiers follow the data. The qualifiers are:

Metals:

B Reported value is less than reporting limit but greater than the instrument detection limit.

\* Duplicate analysis not within control limits set by laboratory QA/QC.

W Postdigestion spike for furnace AA analysis out of control limits (85 to 115%), while sample absorbance is less than 50% of spike absorbance.



**Table 5.5 Chemical Constituents Detected in Groundwater, Background  
(CLP Laboratory Analysis) - Site Investigation, 1992**

Chemical	Round 1 MANG-BG MW1	Round 2 MANG-BG MW1
GC volatile organics ( $\mu\text{g/L}$ )	ND	ND
CLP semivolatile organics ( $\mu\text{g/L}$ )	ND	ND
Metals ( $\mu\text{g/L}$ )		
Arsenic	1.1 BJ	ND
Barium	56 BJ	62.2 B
Lead	4.9 J	4.3 JN
Zinc	15 B*J	9.8 JB
Total petroleum hydrocarbons (mg/L)	1	ND

ND = not detected.

Data qualifiers follow the data. The qualifiers are:

Metals:

- B Reported value is less than reporting limit but greater than the instrument detection limit.
- N Spiked sample recovery not within control limits set by laboratory QA/QC.
- \* Duplicate analysis not within control limits set by laboratory QA/QC.
- J The value reported is an estimated concentrations. This is used when the compound is detected at less than 10 times the amount in an associated preparation blank or less than 5 times the amount in an associated field blank.

### 5.3 SITE 1 - CURRENT FIRE TRAINING AREA

#### 5.3.1 Groundwater Confirmation and Delineation

Results from the two rounds of groundwater samples obtained from monitoring wells 1MW-1 and 1MW-2 are presented on Tables 5.6 and 5.6a. None of the analytes found were detected at concentrations above either State or Federal ARARs. The only VOC detected at a quantifiable value in the upgradient well, 1MW-1 shown on Fig. 5.8, was a low level of benzene in the second round of samples; other VOCs were present but as nondetects or rejected (R) values (Table 5.6a). The downgradient well, 1MW-2, had low-level concentrations of benzene, toluene, and 1,4-dichlorobenzene. SVOCs (phthalates) were present in both wells at low concentrations and are considered laboratory contaminants. Petroleum hydrocarbons as diesel-range organics (at a maximum qualified value of 0.36 mg/L) were present in both rounds at 1MW-1.

Metals arsenic, barium, beryllium, chromium, copper, lead, nickel, and zinc were variously detected, but at levels below Federal or State ARARS.

### 5.4 SITE 6 - AEROSPACE GROUND EQUIPMENT (BUILDING 22) AREA

#### 5.4.1 Soil Screening Results

PID readings were obtained from the ends of the brass sample liners immediately upon opening the split spoon samplers. The results of the PID screening are included as one of the data entry columns of the soil boring logs presented in Appendix B. Initially, it was anticipated that these screening results would be used for selection of intermediate sample intervals for the GC and laboratory analysis. Because of the shallowness of the borings and difficulties in collection of filled liners it was decided to automatically collect an intermediate sample.

#### 5.4.2 Soil Confirmation and Delineation

Vertical soil confirmation and delineation samples for VOC, SVOC, petroleum hydrocarbons, and PPM analysis were collected from three depth intervals from four soil borings—6SB-15, -16, -17, and -18. At boring 6DW1, advanced at the presumed location of the Site 6 dry well, samples were collected from two depths. Sample depths for the soil borings varied but included a sample from 0.5 to around 4 ft, one at refusal—which varied from around 8 ft to 10 ft—and one at an intermediate depth. At the dry well only two samples were collected: one at around 4.5 ft and one at refusal at 7.5 ft. The locations of the borings were intended to delineate the area of soil contamination found during the SI. Locations of the five borings are shown on Fig. 5.9, and the analytical data are presented on Tables 5.7 and 5.8. Boring 6SB-16 was drilled inside Building 25 to evaluate whether contamination from the dry well had migrated beneath the building. 6SB-17 was placed in the area believed to be near, but downgradient from, the abandoned dry well.

##### 5.4.2.1 Volatile and Semivolatile Organic Compound Soil Confirmation and Delineation

Fuel-associated analytes toluene, ethylbenzene, and xylenes (total) were detected in the borings at maximum qualified concentrations of 60,000  $\mu\text{g/kg}$ , 5900  $\mu\text{g/kg}$ , and 37,000  $\mu\text{g/kg}$ , respectively. These data are presented on Table 5.7. The higher concentrations of these

Table 5.6. Groundwater Organic Analyses -Site 1 - 120th FW MANG, Great Falls Montana

SAMPLE INFORMATION									
Site									
Monitoring Well									
Sample Number									
Matrix									
Date Sample									
Date Analyzed									
ANALYTICAL INFORMATION									
VOCs									
Analyte	CRQL	MCLs	MDEQ	Result	1-MW1-GW1	1-MW1-GW2	1-MW2-GW1	1-MW2-GW2	1-MW2-GW3
Chloromethane	1	NE	NE	ND	Water	Water	Water	Water	Water
Chloroethane	1	NE	NE	ND	5/16/96	7/11/96	5/2/96	5/16/96	7/19/96
Acetone	1	NE	NE	R	5/28/96	7/23/96	5/6/96	5/17/96	7/17/96
2-Butanone	5	NE	NE	R					
Chloroform	1	100	57	ND					
Benzene	1	5	5	ND					
Toluene	1	1000	1000	R					
2-Hexanone	1	NE	NE	ND					
1,4-Dichlorobenzene	1	75	75	R					
1,2-Dibromo-3-chloropropane	1	0.2	0.2	R					
Units	ug/l	ug/l	ug/l	ug/l					
SVOCs									
Analyte	CRQL	MCLs	MDEQ	Result	1-MW1-GW1	1-MW1-GW2	1-MW2-GW2	1-MW2-GW2A	1-MW2-GW3
Diethylphthalate	10	NE	23,000	1J	5/16/96	7/11/96	5/16/96	5/16/96	7/9/96
Di-n-butylphthalate	10	NE	2700	1J	5/28/96	7/24/96	5/28/96	5/28/96	7/22/96
bis(2-Ethylhexyl)phthalate	10	NE	6	1J					
Units	ug/l	ug/l	ug/l	ug/l					
Date Sample									
Date Analyzed									
Petroleum Hydrocarbons	RL	MCLs	MDEQ	Result	5/16/96	7/11/96	5/16/96	5/16/96	7/9/96
Disel range, as diesel	0.25	NE	NE	0.35NJ	5/20/96	7/18-25/96	5/20/96	5/20/96	7/17-24/96
Gasoline range	0.25	NE	NE	ND					
Units	mg/l	mg/l	mg/l	mg/l					
Legend									
MCLs	Federal Drinking Water Standard Maximum Contaminant Level								
MDEQ	Montana Department of Environmental Quality Human Health Standards								
NE	ARAs Not Established								
DW	Dry Well								
SB	Soil Boring								
SS	Sediment/Surface Soil								
(DISS)	Dissolved Sample (total metals)								
	Concentration > or = MCLs OR MDEQ, ARAs, or Avg + 2 Standard Dev.								
CRQL	Contract Required Quantitation Limit								
RL	Reporting Limit								
ND	Compound Not Detected								
J	Concentration Estimated								
R	Results Rejected on Basis of Laboratory QA/QC								
N	Presumptive Evidence of Compound								



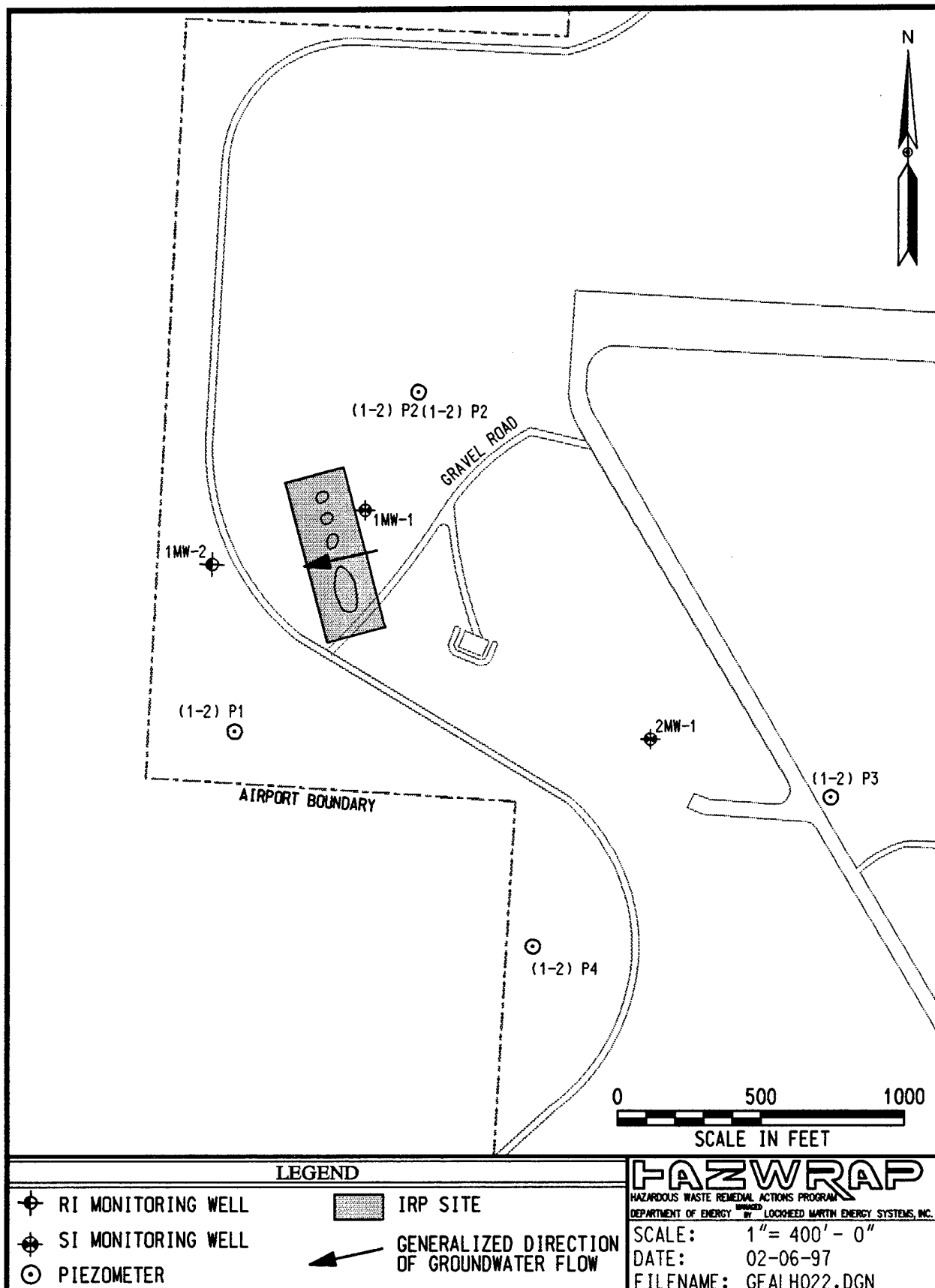


Fig. 5.8. Site 1 Monitoring Well Location Map.  
 120th FW Montana Air National Guard, Great Falls, Montana.

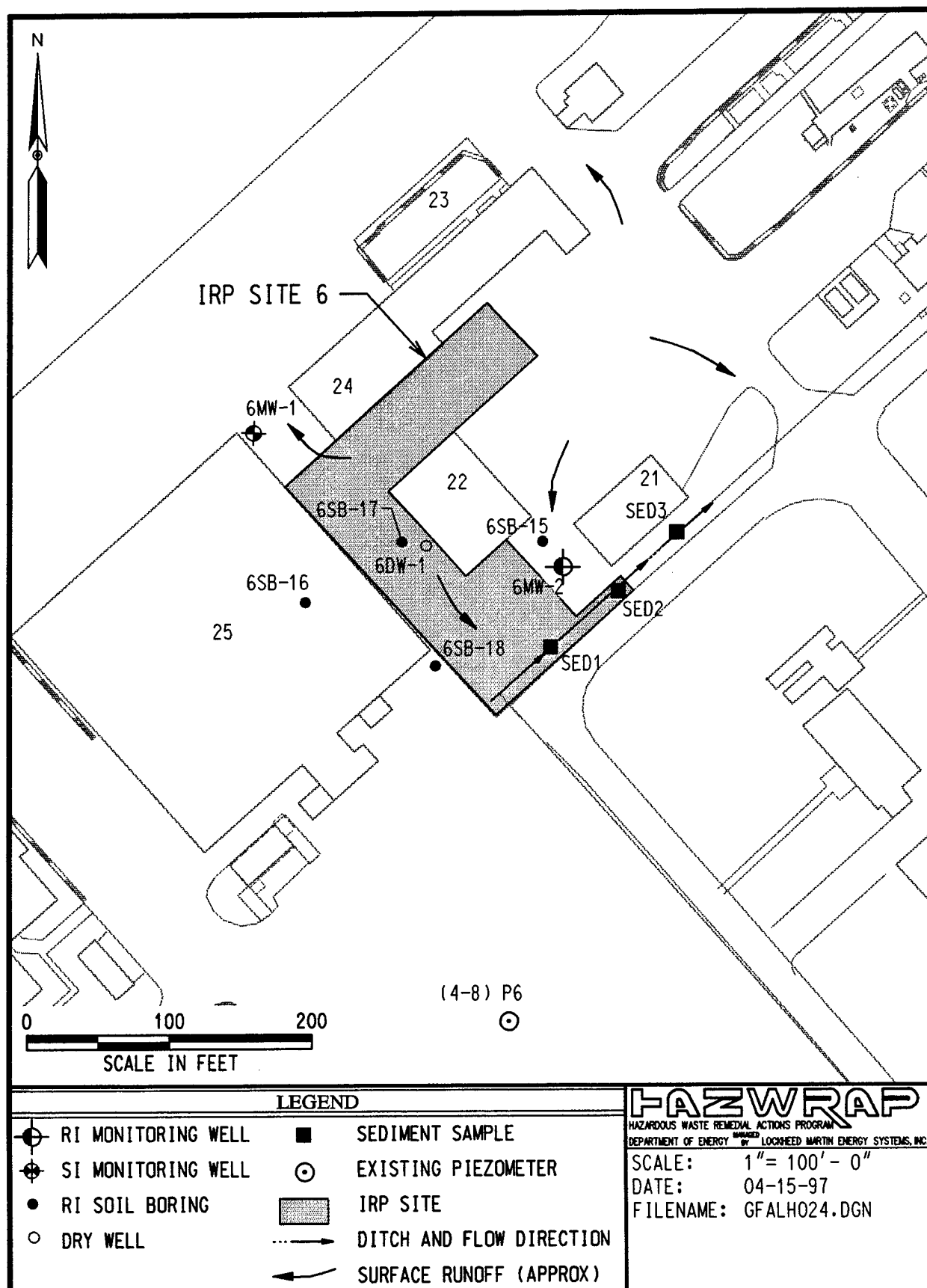


Fig. 5.9. Site 6 Soil Boring and Sediment Sample Locations.  
120th FW Montana Air National Guard, Great Falls, Montana.

Table 5.7. Soils Organic Analytical Data-Site 6 - 120th FW, MANG, Great Falls, Montana

SAMPLE INFORMATION		6DW1	Diluted Sample	6DW1	SB15	Diluted Sample	SB15	SB15	Diluted Sample	SB15	SB16	SB16
Location		4.1-4.6 ft	4.1-4.6 ft	7.3-7.6 ft	0.5-2.5 ft	0.5-2.5 ft	2.5-4 ft	7.7-8.1 ft	7.7-8.1 ft	0.9-3.9 ft	SB16	SB16
Depth		6-DW1-4.1-4.6	6-DW1-4.1-4.6	6-DW1-7.3-7.6	6-SB15-0.5-2.5	6-SB15-0.5-2.5DL	6-SB15-2.5-4	6-SB-15-7.7-8.1	6-SB15-7.7-8.1DL	6-SB16-0.9-3.9	6-SB16-3.9-4.5	6-SB16-8.5-9.5
Sample Number		Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Matrix		4/27/96	4/27/96	4/27/96	4/26/96	4/26/96	4/26/96	4/26/96	4/26/96	4/30/96	5/1/96	5/2/96
Date Sampled												
ANALYTICAL INFORMATION												
VOCs												
Date Analyzed		5/2/96	5/9/96	5/2/96	5/3/96	5/7/96	4/30/96	4/30/96	5/7/96	5/3/96	5/3/96	5/2/96
Analyte	CRQL	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
Acetone	10	ND	ND	ND	1600J	ND	180J	1000J	1300J	130	140	2000
Carbon Disulfide	10	ND	ND	ND	ND	ND	ND	2J	ND	ND	ND	ND
Methylene Chloride	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone	10	ND	250J	ND	43J	ND	8J	7J	ND	8J	9J	ND
Chloroform	10	ND	ND	ND	ND	ND	ND	ND	ND	1J	ND	ND
Trichloroethene	10	280J	230J	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-Pentanone	10	ND	ND	ND	ND	ND	ND	ND	ND	11J	ND	ND
Toluene	10	60,000J	55,000J	4500	ND	ND	4J	ND	ND	5J	5J	ND
2-Hexanone	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	10	5400	5900J	1900	2J	ND	ND	ND	ND	ND	ND	100J
1,2-Dichloroethene	10	350J	250J	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylene	10	34,000	37,000J	14,000	5J	ND	ND	ND	ND	ND	ND	510J
Units	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
SVOCs												
Date Analyzed		5/10/96		5/10/96	5/15/96		5/14/96	5/14/96				
Analyte	CRQL	Result	Result	Result	Result		Result	Result		Result	Result	Result
Naphthalene	330	11,000		1500	ND		ND	ND		ND	ND	200
2-Methylnaphthalene	330	12,000		1500	ND		ND	ND		ND	ND	170J
Fluorene	330	ND		40J	ND		ND	ND		ND	ND	ND
Di-n-butylphthalate	330	220J		120J	ND		ND	ND		ND	ND	ND
bis(2-Ethylhexyl)phthalate	330	2900J		190J	ND		ND	58J		280J	560J	190J
Di-n-octylphthalate	330	ND		ND	ND		ND	ND		19J	50J	ND
Units	ug/kg	ug/kg		ug/kg	ug/kg		ug/kg	ug/kg		ug/kg	ug/kg	ug/kg
Petroleum Hydrocarbons												
Date Analyzed		5/10-20/96		5/10-20/96	5/9/96		5/9/96	5/9/96				
JP-4	RL	Result	Result	Result	Result		Result	Result		Result	Result	Result
10	10	5700		1300	ND		ND	95		ND	ND	270
Disel Range, as diesel	10	1900		400	ND		ND	290		ND	17	130
Oil Range, as oil	100	10,000		540	ND		ND	79		ND	ND	300
Gasoline Range	5	7300NJ		1700NJ	ND		ND	ND		ND	ND	460NJ
Units	mg/kg	mg/kg		mg/kg	mg/kg		mg/kg	mg/kg		mg/kg	mg/kg	mg/kg
Legend												
MCLs		Federal Drinking Water Standard Maximum Contaminant Level										
MDEQ		Montana Department of Environmental Quality Human Health Standards										
NE		ARAs Not Established										
DW		Dry Well										
SB		Soil Boring										
SS		Sediment/Surface Soil										
(DSS)		Dissolved Sample (total metals)										
		Concentration > or = MCLs OR MDEQ, ARARs, or Ave + 2 Standard Dev.										
CRQL		Contract Required Quantitation Limit										
RL		Reporting Limit										
ND		Compound Not Detected										
J		Concentration Estimated										
R		Results Rejected on Basis of Laboratory QM/QC										
N		Presumptive Evidence of Compound										

Table 6.7. SoilsOrganic Analytical Data-Site 6 - 120th FW, MANG, Great Falls, Montana (cont)

SAMPLE INFORMATION		SB17	SB17	SB17	SB17	SB17	SB18	SB18	SB18	SB18	Diluted Sample	Diluted Sample
Location		0.5-2.5 ft	4.5-5.8 ft	9.5-9.9 ft	6.4-7.3 ft	6.4-7.3 ft	0.5-2.5	6.4-7.3 ft	6.4-7.3 ft	6.4-7.3 ft	SB18	SB18
Depth		0.5-2.5 ft	4.5-5.8 ft	9.5-9.9 ft	6.4-7.3 ft	6.4-7.3 ft	0.5-2.5	6.4-7.3 ft	6.4-7.3 ft	6.4-7.3 ft	SB18	SB18
Sample Number		6-SB17-0.5-2.5	6-SB17-4.5-5.8	6-SB17-9.5-9.9	6-SB18-6.4-7.3	6-SB18-6.4-7.3	6-SB18-0.5-2.5	6-SB18-6.4-7.3	6-SB18-6.4-7.3	6-SB18-6.4-7.3	6-SB18-6.4-7.3	6-SB18-6.4-7.3
Matrix		Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Date Sampled		4/26/96	4/26/96	4/26/96	4/26/96	4/26/96	4/26/96	4/26/96	4/26/96	4/26/96	4/26/96	4/26/96
ANALYTICAL INFORMATION												
VOCs												
Date Analyzed		5/7/96	5/2/96	5/2/96	5/2/96	5/2/96	4/30/96	4/30/96	4/30/96	4/30/96	5/7/96	5/2/96
Analyte	CRQL	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
Acetone	10	ND	1800	ND	ND	ND	ND	2000J	2000J	2000J	2600J	2100J
Carbon Disulfide	10	ND	ND	ND	ND	ND	1J	2J	2J	2J	ND	ND
Methylene Chloride	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone	10	ND	ND	ND	ND	ND	9J	5J	5J	5J	ND	ND
Toluene	10	19,000	6400	5100	5100	5100	ND	ND	ND	ND	ND	ND
2-Hexanone	10	ND	ND	ND	ND	ND	4J	ND	ND	ND	ND	ND
Ethylbenzene	10	3600	640J	1200J	1200J	1200J	ND	ND	ND	ND	ND	ND
1,2-Dichloroethene	10	440J	130J	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylene	10	26,000	4600	8100	8100	8100	ND	ND	ND	ND	ND	ND
Units	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
SVOCs												
Date Analyzed		5/6/96	5/10/96	5/10/96	5/10/96	5/10/96	5/14/96	5/14/96	5/14/96	5/14/96	5/15/96	5/15/96
Analyte	CRQL	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
Naphthalene	330	420	13,000	2000	2000	2000	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	330	110J	12,000	1300	1300	1300	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	330	ND	ND	120J	120J	120J	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	330	ND	1200J	160J	160J	160J	59J	90J	90J	90J	51J	51J
Units	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Petroleum Hydrocarbons												
Date Analyzed		5/13/96	5/13/96	5/13/96	5/13/96	5/13/96	5/9/96	5/10/96	5/10/96	5/10/96	5/9/96	5/9/96
Analyte	RL	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
JP-4	10	1300	7800	2600	2600	2600	ND	ND	ND	ND	76	76
Disel Range, as diesel	10	18NJ	2800	690	690	690	ND	ND	ND	ND	71	71
Oil Range, as oil	100	ND	14,000	1100	1100	1100	ND	ND	ND	ND	ND	ND
Gasoline Range	5	2600NJ	17,000NJ	2900NJ	2900NJ	2900NJ	ND	ND	ND	ND	110	110
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Legend												
MCLs	Federal Drinking Water Standard Maximum Contaminant Level											
MDEQ	Montana Department of Environmental Quality Human Health Standards											
NE	ARAs Not Established											
DW	Dry Well											
SB	Soil Boring											
SS	Sediment/Surface Soil											
(DSS)	Dissolved Sample (total metals)											
	Concentration > or = MCLs OR MDEQ, ARARs, or Aves + 2 Standard Dev.											
CRQL	Contract Required Quantitation Limit											
RL	Reporting Limit											
ND	Compound Not Detected											
J	Concentration Estimated											
R	Results Rejected on Basis of Laboratory QA/QC											
N	Presumptive Evidence of Compound											



Table 6.8. Soil Inorganic Analytical Data - Site 6 - 120th FW, MANG, Great Falls, Montana

SAMPLE INFORMATION		AVG. ±1 TWO STD. DEV.		6		6		6		6		6		6	
Site		DW1		DW1		SB15		SB15		SB15		SB16		SB16	
Location		6-DW1-1-4.6		6-DW1-7.3-7.6		6-SB15-0.5-2.5		6-SB15-2.5-4		6-SB15-7.7-8.1		6-SB16-0.9-3.9		6-SB16-3.9-4.5	
Sample Number															
Matrix		soil		soil		soil		soil		soil		soil		soil	
Date Sampled		4/27/96		4/27/96		4/26/96		4/26/96		4/26/96		4/30/96		4/30/96	
Date Analyzed		5/9/96 - 6/14/96		5/9/96 - 6/14/96		5/7-14/96		5/7-14/96		5/7-14/96		5/9/96 - 6/14/96		5/9/96 - 6/14/96	
ANALYTICAL INFORMATION															
INORGANICS															
Analyte		RESULT		RESULT		RESULT		RESULT		RESULT		RESULT		RESULT	
Arsenic		1.9 - 9.9		3.3		5.4		2.7		5.2J		15.2		7.2	
Barium		ND - 1231		273		468		118		145		199		250	
Beryllium		NE		0.33J		0.28J		0.25J		0.23J		0.32J		0.37J	
Chromium		8.7 - 22.7		13.1		11.3		ND		11		10.4		12	
Copper		8.7 - 19.7		14.9		34.2		17.1		9.9		11.7		17.6	
Lead		3.4 - 13		55.8		19.1		5.8		6.3		14.3		8.5	
Mercury		NE		ND		ND		ND		ND		0.09		ND	
Nickel		3.6 - 17.6		8.6		7.8		8.2		8.4		10.7		9.4	
Thallium		NE		ND		ND		ND		ND		ND		ND	
Zinc		21.6 - 61.3		52.5		35.3		36.6		47.9		40.2		40.6	
Units (mg/kg) Soil, (ug/L) Water															

SAMPLE INFORMATION		AVG. ±1 TWO STD. DEV.		6		6		6		6		6		6	
Site		SB17		SB17		SB17		SB18		SB18		SB18		SB18	
Location		6-SB17-0.5-2.5		6-SB17-4.5-5.8		6-SB17-9.5-9.9		6-SB18-0.5-2.5		6-SB18-6.4-7.3		6-SB18-8.3		6-SB18-8.3	
Sample Number															
Matrix		soil		soil		soil		soil		soil		soil		soil	
Date Sampled		4/26/96		4/26/96		4/26/96		4/26/96		4/26/96		4/26/96		4/26/96	
Date Analyzed		5/8-13/97		5/8-13/97		5/8-13/97		5/7-14/96		5/7-14/96		5/7-14/96		5/7-14/96	
ANALYTICAL INFORMATION															
INORGANICS															
Analyte		RESULT		RESULT		RESULT		RESULT		RESULT		RESULT		RESULT	
Arsenic		1.9 - 9.9		ND		ND		6.9		5.7		3.7		3.7	
Barium		ND - 1231		444		119		258		248		306		306	
Beryllium		NE		ND		ND		0.46J		0.27J		0.24J		0.24J	
Chromium		8.7 - 22.7		9.2		7.1		7.8		10.5		9.8		12.9	
Copper		8.7 - 19.7		10.7		13.4		15.3		16.9		32.7		9.6	
Lead		3.4 - 13		4.4		8.8		5.9		8.7		6.9		5.1	
Mercury		NE		0.1		ND		ND		0.11		ND		ND	
Nickel		3.6 - 17.6		9.4		11.9		11.3		8.7		8.7		8.9	
Thallium		NE		ND		0.34		0.42		ND		ND		ND	
Zinc		21.6 - 61.3		32.8		38.9		49.4		52.3		33.2		33.2	
Units (mg/kg) Soil, (ug/L) Water															

Legend  
MCLs Federal Drinking Water Standard Maximum Contaminant Level  
MDEQ Montana Department of Environmental Quality Human Health Standards  
NE ARAs Not Established  
DW Dry Well  
SB Soil Boring  
SS Sediment/Surface Soil  
(DISC) Dissolved Sample (total metals)  
Concentration > or = MCLs OR MDEQ, ARAs, or Arge + 2 Standard Dev.  
CRQL Contract Required Quantitation Limit  
RL Reporting Limit  
ND Concentration Not Detected  
J Concentration Estimated  
R Results Rejected on Basis of Laboratory QA/QC  
N Presumptive Evidence of Compound

fuel compounds were found in the boring advanced at the presumed dry well location and at 6SB-17. Boring 6DW1 and 6SB-17 were also the only borings to detect the chlorinated solvents trichloroethene (TCE) and 1,2-dichloroethene; detections of TCE reached a maximum data-qualified value of 280  $\mu\text{g/kg}$  in 6DW1 and 1,2-dichloroethene reached a maximum qualified value of 440  $\mu\text{g/kg}$  in 6SB-17. Similarly high concentrations of fuel and the chlorinated compound TCE were detected in the two SI borings, SB3 and SB4 (Table 2.1), also located near the suspected location of the dry well. Several other volatile compounds detected at low-level qualified concentrations were carbon disulfide (maximum, 2  $\mu\text{g/kg}$ ), chloroform (maximum, 1  $\mu\text{g/kg}$ ), and 4-methyl-2-pentanone (maximum, 11  $\mu\text{g/kg}$ ).

Maximum VOC detections of analytes commonly considered to be either laboratory or field decontamination and sampling artifacts were acetone, 2600  $\mu\text{g/kg}$ ; 2-butanone, 43  $\mu\text{g/kg}$ ; methylene chloride, 250  $\mu\text{g/kg}$ ; and 2-hexanone, 5  $\mu\text{g/kg}$ . For these chemicals commonly identified as artifacts resulting from laboratory or field procedures (e.g., phthalate esters and acetone) the chemical was considered to be site related (not an artifact) if the maximum concentration detected was equal to or greater than ten times the blank concentration (US EPA 1994).

Semivolatile organics detected in the soil samples include the fuel-related compounds naphthalene and 2-methylnaphthalene; maximum concentrations were 13,000  $\mu\text{g/kg}$  and 12,000  $\mu\text{g/kg}$ , respectively. Similar to the VOC concentrations, the higher detections were from the soils at 6DW1 and 6SB-17. Several phthalate compounds were also detected at relatively low concentrations—bis(2-ethylhexyl) phthalate, di-n-butylphthalate, and di-n-octylphthalate (Table 5.7). Phthalates are common laboratory and sampling contaminants and, although these detections are greater than ten times the level in associated blanks, their presence may still be attributed to contamination introduced through the sampling and analytical process.

Petroleum hydrocarbons analyzed as JP-4, diesel range as diesel, oil range as oil, and gasoline-range organics were detected in all five borings. The highest concentrations of petroleum hydrocarbons were found in the three samples from 6SB-17: JP-4 was found at maximum concentrations of 7800 mg/kg, diesel-range organics at 2800 mg/kg, oil-range organics at 14,000 mg/kg, and gasoline range at a maximum qualified concentration of 17,000 mg/kg. Significant but lesser concentrations of petroleum hydrocarbons were detected in 6DW1. Petroleum hydrocarbons in the other borings were present at very much lower concentrations and were mainly restricted to the sample collected at the refusal depth.

#### 5.4.2.2 Inorganic Soil Compound Confirmation and Delineation

Concentrations of metals above background levels were found in the soil borings and dry well samples at Site 6. These data are presented in Table 5.8. Comparison of these detections were made against the average background concentration plus two standard deviations. If background concentrations follow a normal distribution, the average plus two standard deviations will include 95.4% of the values. Based on this, four metals were indicated to be above the background range: arsenic (maximum, 15.2 mg/kg), copper (maximum, 41.7 mg/kg), lead (maximum, 58.8 mg/kg), and zinc (maximum, 65.3 mg/kg). Detections of beryllium, mercury, and thallium were also found in the Site 6 soil boring samples but were not present in the background samples. The range of these concentrations are below or within the range of concentrations reported for the western United States (Shacklette 1984).

#### 5.4.2.3 Sediment/Surface Soil Confirmation and Delineation

Analytical data from three sediment/surface soil samples collected from a drainage ditch located at the southeastern edge of the site are presented on Table 5.9; sampling locations are shown on Fig. 5-9.

The drainage ditch primarily receives surface water runoff from the large area of asphalt to the west-northwest. VOC detections were restricted to low levels of possible laboratory contaminants carbon disulfide, methylene chloride, and 2-hexanone. Although detections were greater than ten times the associated blanks, the possibility of laboratory or field contamination cannot be precluded. The VOC 4-methyl-2-pentanone was also detected (nondetect to 5  $\mu\text{g/kg}$ ).

Seven PAHS were detected. All detections were qualified (estimated J) values with maximum concentrations of analytes as follows: fluoranthene (220  $\mu\text{g/kg}$ ), pyrene (490  $\mu\text{g/kg}$ ), chrysene (490  $\mu\text{g/kg}$ ), benzo[b]fluoranthene and benzo[k]fluoranthene (660  $\mu\text{g/kg}$ ), benzo[a]pyrene (380  $\mu\text{g/kg}$ ), ideno[1,2,3-cd]pyrene (110  $\mu\text{g/kg}$ ), and benzo[g,h,i]perylene (620  $\mu\text{g/kg}$ ).

Petroleum hydrocarbons were present in the form of diesel-range organics qualified at a maximum concentration of 1100 mg/kg and oil-range organics qualified at a concentration of 3700 mg/kg.

Five metals were above the background criteria of the average background value plus two standard deviations (Table 5.9). These metals and their maximum detected concentrations were chromium (83.1 mg/kg), copper (63.4 mg/kg), lead (758 mg/kg), nickel (24.5 mg/kg), and zinc (368 mg/kg).

#### 5.4.3 Groundwater Confirmation and Delineation

Results from the two rounds of groundwater sampling at Site 6 indicated the presence of volatiles, semivolatiles, petroleum hydrocarbons, and dissolved metals. None of the analytes detected were above either federal maximum contaminant levels (MCLs) or MDEQ ARARs. The groundwater data are presented in Tables 5.10 and 5.11. Locations of monitoring wells are shown on Fig. 5.10.

VOCs detected included the following chlorinated compounds and their potential degradation products: TCE, 1,1,2-TCE, cis-1,2-dichloroethene, and 1,1-dichloroethene. Concentrations of these compounds show a consistent decrease from the first to the second sampling event. Low-level concentrations of fuel compounds benzene, toluene, ethylbenzene, and total xylenes were also reported but with no trend between the two sampling rounds. Other volatile compounds detected were 4-methyl-2-pentanone, 1,4-dichlorobenzene, and 1,2-dibromo-3-chloropropane, whose value was rejected for a quality control problem or matrix interference. The common laboratory and sampling contaminants acetone, 2-butanone, and 2-hexanone were also present at low levels of concentration. Although these detections were greater than ten times the level in associated blanks, their presence may still be attributed to contamination introduced through the sampling and analytical processes.

**Table 5.9. Sediment/Surface Soil Organic and Inorganic Analytical Data -  
Site 6 - 120th FW, MANG, Great Falls Montana**

SAMPLE INFORMATION					
Site		SS1	SS2	SS3	
Depth		0-1 ft	0-1ft	0-1ft	
Sample Number		MANG-SS1-0-1	MANG-SS2-0-1	MANG-SS3-0-1	
Matrix		Soil	Soil	Soil	
Date Sampled		7/11/96	7/11/96	7/11/96	
Date Analyzed		7/19/96	7/19/96	7/19/96	
ANALYTICAL INFORMATION					
VOCs					
Analytes	CRQL	Result	Result	Result	
Carbon Disulfide	10	ND	ND	1J	
Methylene Chloride	10	3J	3J	3J	
4-Methyl-2-Pentanone	10	ND	5J	ND	
2-Hexanone	10	2J	6J	8J	
Units	ug/kg	ug/kg	ug/kg	ug/kg	
Date Analyzed					
SVOCs					
Analytes	CRQL	Result	Result	Result	
Di-n-butylphthalate	10000	130J	ND	ND	
Fluoranthene	10000	190J	220J	ND	
Pyrene	10000	490J	280J	130J	
Chrysene	10000	490J	ND	240J	
Benzo[b]fluoranthene	10000	540J	660J	170J	
Benzo[a]pyrene	10000	ND	380J	ND	
Indeno[1,2,3-cd]pyrene	10000	110J	ND	ND	
Benzo[g,h,i]perylene	10000	340J	620J	ND	
Units	ug/kg	ug/kg	ug/kg	ug/kg	
Date Analyzed					
Petroleum Hydrocarbons					
Petroleum Hydrocarbons	RL	Result	Result	Result	
Diesel Range, as diesel	25	900NJ	1100NJ	680NJ	
Oil Range, as oil	100	3700NJ	500NJ	1300NJ	
Units	mg/kg	mg/kg	mg/kg	mg/kg	
Date Analyzed		7/23/96-8/1/96	7/23/96-8/1/97	7/23/96-8/1/98	AVG +/- TWO
Inorganics					
Inorganics	CRDL	Result	Result	Result	STD. DEV
Antimony	*6	0.83J	1.1J	ND	NE
Arsenic	10	6J	7.6J	6.8J	1.9 - 9.9
Barium	200	370J	458J	276J	ND - 1231
Beryllium	*4	0.55J	0.66J	0.49J	NE
Cadmium	5	4.3	11.9	2.1	NE
Chromium	10	83.1J	80.5J	19.1J	8.7 - 22.7
Copper	25	38.9	63.4	26.3	8.7 - 19.7
Lead	3	173	758	327	3.4 - 13
Mercury	0.2	ND	ND	ND	NE
Nickel	40	14.2	24.5	12.8	3.6 - 17.6
Selenium	5	ND	ND	ND	ND - 0.66
Silver	10	ND	1.6J	ND	NE
Thallium	*2	ND	ND	ND	NE
Zinc	20	235	368	184	21.6 - 61.3
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg

**Legend**

MCLs	Federal Drinking Water Standard Maximum Contaminant Level
MDEQ	Montana Department of Environmental Quality Human Health Standards
NE	ARAs Not Established
DW	Dry Well
SB	Soil Boring
SS	Sediment/Surface Soil
(DISS)	Dissolved Sample (total metals)
	Concentration > or = MCLs or MEDQ ARARs, or Ave + 2 Standard Dev.
CRQL	Contract Required Quantitation Limit
RL	Reporting Limit
ND	Compound Not Detected
J	Concentration Estimated
R	Results Rejected on Basis of Laboratory QA/QC
N	Presumptive Evidence of Compound

Table 5.10. Groundwater Organic Analytical Data - Site 6 - 120th FW, MANG, Great Falls, Montana

SAMPLE INFORMATION									
Site									
Monitoring Well									
Sample Number									
Matrix									
Date Sampled									
Date Analyzed									
ANALYTICAL INFORMATION									
VOCs									
Analyte	CRQL	MCLs	MDEQ	Result	6	6	6	6	Field Duplicate
Acetone	1	NE	NE	R	6	MW-1	MW-2	MW-3	6
1,1-Dichloroethane	1	NE	NE	R	6	MW-1-GW1	6-MW2-GW2	6-MW3-GW1	6-MW3-GW2
1,2-Dichloroethane	1	70	70	R	6	Water	Water	Water	Water
2-Butoxene	5	NE	NE	R	6	5/18/96	5/13/96	5/14/96	7/10/96
Benzene	1	5	5	R	6	5/10/96	5/15/96	5/24/96	7/17/96
Trichloroethene	1	5	5	R	6	7/10/96	7/10/96	7/10/96	7/10/96
4-Methyl-2-pentanone	5	NE	NE	R	6	7/10/96	7/10/96	7/10/96	7/10/96
Toluene	1	1,000	1,000	R	6	7/10/96	7/10/96	7/10/96	7/10/96
1,1,2-Trichloroethane	1	5	5	R	6	7/10/96	7/10/96	7/10/96	7/10/96
2-Hexanone	1	NE	NE	R	6	7/10/96	7/10/96	7/10/96	7/10/96
Ethylbenzene	1	700	700	R	6	7/10/96	7/10/96	7/10/96	7/10/96
1,4-Dichlorobenzene	1	75	75	R	6	7/10/96	7/10/96	7/10/96	7/10/96
1,2-Dibromo-3-chloropropane	1	0.2	0.2	R	6	7/10/96	7/10/96	7/10/96	7/10/96
Xylenes	1	10,000	10,000	R	6	7/10/96	7/10/96	7/10/96	7/10/96
Units	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
SVOCs									
Analyte	CRQL	MCLs	MDEQ	Result	6	6	6	6	Field Duplicate
4-Methylphenol	10	NE	NE	R	6	MW-1	MW-2	MW-3	6
Napthalene	10	NE	NE	R	6	MW-1-GW1	6-MW2-GW2	6-MW3-GW1	6-MW3-GW2
2-Methylnaphthalene	10	NE	NE	R	6	Water	Water	Water	Water
Acenaphthene	10	NE	20	R	6	5/18/96	5/13/96	5/14/96	7/10/96
Dibenzofuran	10	NE	NE	R	6	5/10/96	5/15/96	5/24/96	7/17/96
Fluorene	10	NE	13,000	R	6	7/10/96	7/10/96	7/10/96	7/10/96
Dibenzylidene	10	NE	23,000	R	6	7/10/96	7/10/96	7/10/96	7/10/96
Di-n-butylphthalate	10	NE	2700	R	6	7/10/96	7/10/96	7/10/96	7/10/96
Phenanthrene	10	NE	NE	R	6	7/10/96	7/10/96	7/10/96	7/10/96
Anthracene	10	NE	9,600	R	6	7/10/96	7/10/96	7/10/96	7/10/96
Fluoranthene	10	NE	300	R	6	7/10/96	7/10/96	7/10/96	7/10/96
Bis(2-Ethylhexyl)phthalate	10	NE	3000	R	6	7/10/96	7/10/96	7/10/96	7/10/96
Units	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Legend									
Federal Drinking Water Standard Maximum Contaminant Level									
Montana Department of Environmental Quality Human Health Standards									
MCLs									
MDEQ									
NE									
DRI Well									
Dry Well									
SB									
Sediment/Surface Soil									
SS									
(DISS)									
Concentration > or = MCLs OR MDEQ, ARARs, or Avgs + 2 Standard Dev.									
Contract Required Quantitation Limit									
Reporting Limit									
ND									
Concentration Not Detected									
J									
Concentration Estimated									
R									
Results Rejected on Basis of Laboratory QA/QC									
Presumptive Evidence of Compound									
N									

**Table 5.11. Groundwater Inorganic Analytical Data - Site 6 - 120th FW, MANG, Great Falls, Montana**

SAMPLE INFORMATION			6			6			6			6			6		
Site			6-DW			MW1			MW1			Field Duplicate			6		
Monitoring Well			6-DW1-W1			6-MW1-GW2 (Ch3)			6-MW1-GW2 (Ch3)			6-MW2-GW1 (Ch3)			6-MW2-GW2 (Ch3)		
Matrix			470866			571368			710168			571368			710168		
Sampled			5/24/98			5/14/98			7/10/98			5/13/98			7/10/98		
Date Analyzed			5/8-13/98			5/24/98 - 8/4/98			7/11-24/98			5/24/98 - 8/21/98			7/11-24/98		
ANALYTICAL INFORMATION																	
CRDL	MCLs	MDLQ	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
6	6	6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
6	6	44.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
6	6	Autonomy	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
20	2000	1000	578	1521	233	1843	1191	202	1843	202	1843	202	1843	202	1843	202	1843
4	4	40	ND	ND	ND	ND	ND	0.5J	0.5J	0.5J	0.5J	0.5J	0.5J	0.5J	0.5J	0.5J	0.5J
10	100	100	945	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
25	1300**	1000	1640	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
15	15	15	1280	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
40	40	100	1040	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
10	10	10	631	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
10	10	10	631	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2	2	2	2.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
20	NE	5000	1730	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	Zinc	Zinc	33.3	6.5J	ND	ND	ND	107	6.5J	ND	ND	ND	ND	ND	ND	ND	ND
ug/L	ug/L	ug/L	5000	1730	ND	ND	ND	107	6.5J	ND	ND	ND	ND	ND	ND	ND	ND
Urea (mg/kg) Sol. (ug/L) Water																	
42.7																	

SAMPLE INFORMATION						ANALYTICAL INFORMATION					
Site						CRED.	MCLs	MDQL			
Monitoring Well											
Sample Number											
Matrix											
Date Sampled											
Date Analyzed											
<b>ANALYTICAL INFORMATION</b>											
<b>INORGANICS</b>											
Analyte											
Arsenic						10	60	18			
Barium						200	2000	1000			
Beryllium						4	4	40			
Chromium						10	100	100			
Copper						25	1300**	1000			
Lead						3	15*	15			
Nickel						40	100	100			
Selenium						6	60	50			
Zinc						20	NE	5000			
Zinc (mg/kg) Soil (ug/L) Water											

Legend	
MCAs	Federal Drinking Water Standard Medium Contaminant Level
MDEQ	Michigan Department of Environmental Quality Human Health Standards
NE	ADARs Not Detected
DW	Drinking Water
SS	Soil Sampling
SSS	Sediment/Surface Soil
(DISS)	Disseminated Sample (total metals)
	Concentration > = MC/L or MDEQ ADARs, or Avg. >2 Standard Dev.
CR	Contract Required Quantitation Limit
RL	Reporting Limit
ND	Compound Not Detected
Q	Quantitation Limit
QOC	Results Reported on Basis of Laboratory QOC
PP	Presumptive Evidence of Compound
AN	Action Level

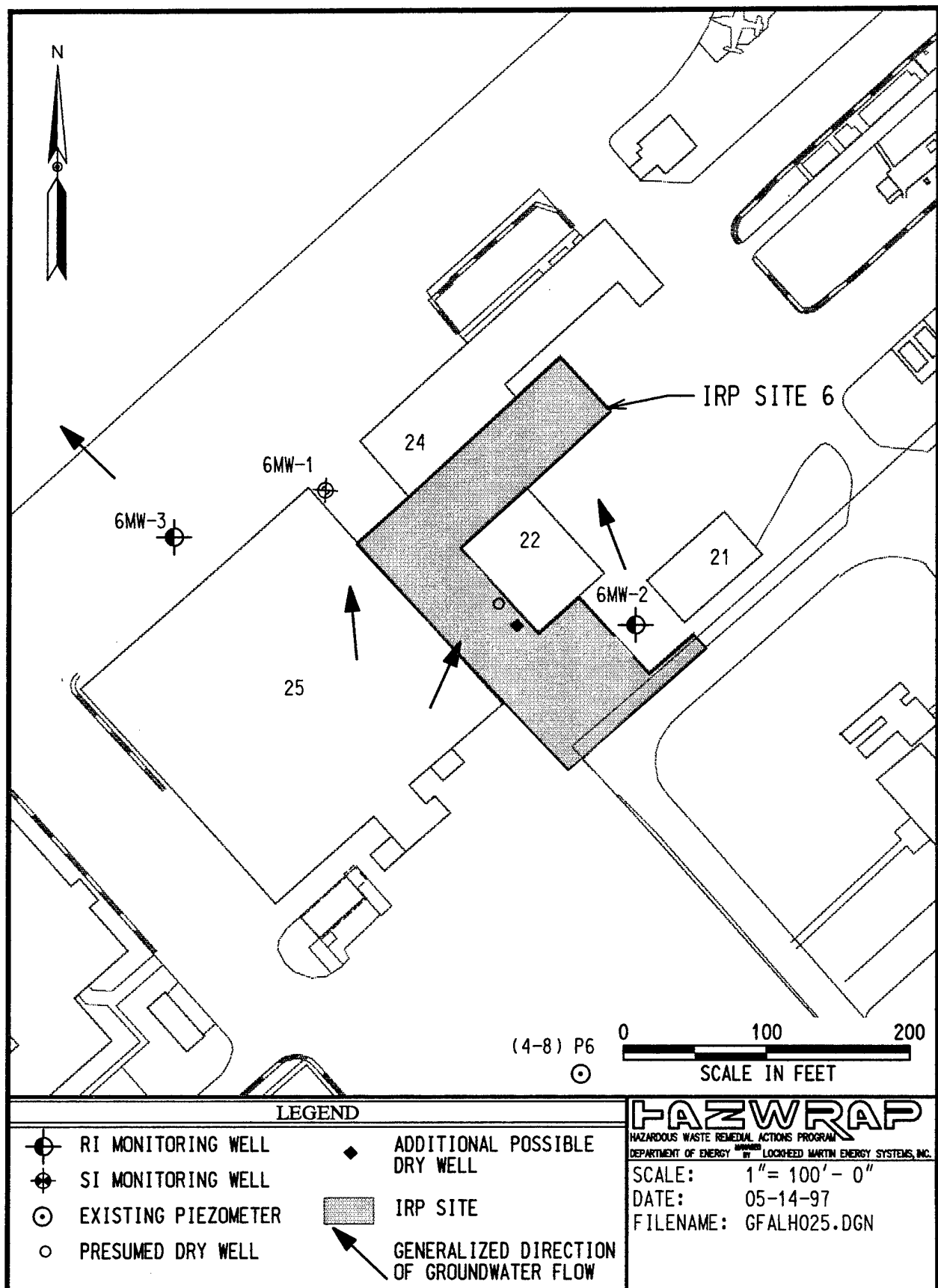


Fig. 5.10. Site 6 Monitoring Well Location Map.  
120th FW Montana Air National Guard, Great Falls, Montana.

Numerous SVOC detections were found, but all concentrations were low and below any State or Federal ARARs; the maximum value was a qualified (estimated J) 1  $\mu\text{g/L}$ . These included fuel components and PAHs; the individual analytes are listed on Table 5.10.

Relatively low levels of petroleum hydrocarbons were detected in all three Site 6 wells. JP-4 was detected at a maximum estimated concentration of 3.3 mg/L and diesel-range organics at 3.7 mg/L; oil-range organics were detected at a maximum concentration of 2.3 mg/L and gasoline-range organics at a maximum of 0.97 mg/L.

Dissolved (filtered) and total inorganic detections included arsenic, barium, beryllium, chromium, copper, lead, nickel, selenium, and zinc (Table 5.11). None of these metals were at concentrations above State or Federal ARARs. Arsenic, barium, lead, and zinc were all variously detected in the background groundwater samples but at levels below those found in Site 6 wells (these background data are presented on Table 5.5).

#### **5.4.4 Dry Well**

Magnetic detectors and drill augers were used to locate and partially expose the lid of an additional possible dry well adjacent to Building 22. Inspection of as-built drawings supplied by the Base confirmed its presence and that the dry well does not appear to be of a construction design that would allow loss of fluids into the surrounding soil. Analytical results from the fluid sample collected detected various VOCs (including TCE, toluene, 2-hexanone, ethylbenzene, and xylenes). SVOCs (including 4-methylphenols, 2-methylnaphthalene, and three phthalate compounds), petroleum hydrocarbons (JP-4 range organics, DROs, and GROs), and metals (antimony, cadmium, chromium, copper, lead, mercury, nickel, thallium, and zinc). The location of the additional dry well is shown on Fig. 5.10 and the data are included on Tables 5.10 and 5.11.

### **5.5 SITE 7 - DRY WELL OFF CORROSION CONTROL BUILDING (BUILDING 23)**

#### **5.5.1 Soil Screening Results**

Field screening of each split spoon sampler was performed with a PID check of each of the ends of the brass sampling liners. These data are included on the boring logs presented in Appendix B.

#### **5.5.2 Soil Confirmation and Delineation**

The location of the four RI soil borings at Site 7 were to confirm the vertical extent and areal extent of soil contamination. GPR data collected during the SI was used to position a boring, 7DW-1, coincident with the presumed location of the Site 7 dry well. Borings 7SB-5 and 7SB-7 were located on either side of the dry well, and 7SB-6 was positioned to evaluate other suspected contamination.

Of the four soil borings advanced during the SI, only boring SB3 detected fuel and fuel-related contaminants (Table 2.5 and Fig. 2.4). Detection of fuel compounds and their maximum concentrations were benzene (2600  $\mu\text{g/kg}$ ), toluene (140,000  $\mu\text{g/kg}$ ), ethylbenzene



(24,000  $\mu\text{g/kg}$ ), total xylenes (159,000  $\mu\text{g/kg}$ ), naphthalene (22,000  $\mu\text{g/kg}$ ), 2-methylnaphthalene (42,000  $\mu\text{g/kg}$ ), and TPH (19,000  $\mu\text{g/kg}$ ). The location of SB3, 25 ft upgradient and to the east of the dry well at Site 7, suggests this occurrence may not be related to the dry well itself and may represent an isolated fuel spill. Samples collected from SI boring SB1 located downgradient 20 ft from the dry well and SB4, located adjacent to SB3, did not detect any fuel compounds.

#### 5.5.2.1 Volatile and Semivolatile Organic Compound Soil Confirmation and Delineation

Exclusive of the dry well samples, VOC contamination related to fuel components was found in three borings; none were detected in the samples from the dry well boring. The location of borings is presented on Fig. 5.11 and analytical data in Table 5.12 and Table 5.13. Concentrations were higher in the samples taken at refusal at the weathered sandstone/bedrock interface. Benzene was found only in boring SB-5 at a maximum concentration of 830  $\mu\text{g/kg}$ ; toluene, ethylbenzene, and total xylenes occurred in all three borings; maximum concentrations for these three analytes were 5,700  $\mu\text{g/kg}$ , 13,000  $\mu\text{g/kg}$ , and 80,000  $\mu\text{g/kg}$ , respectively. The boring advanced at the location believed to be that of the dry well, 7DW-1, met refusal at a depth of 4.2 ft. Data from this depth and the shallower interval sampled had relatively low-level VOC detections. Other analytes detected at low levels were TCE, carbon disulfide, chloroform, and 4-methyl-2-pentanone.

VOC detections of analytes commonly considered to be either laboratory or field decontamination and sampling contaminants were detected in every soil boring. These contaminants were acetone, methylene chloride, 2-butanone, and 2-hexanone. Although these detections are greater than ten times the level in associated blanks, their presence may still be attributed to contamination introduced through the sampling and analytical processes.

Petroleum hydrocarbons—detected as JP-4, diesel-, oil-, and gasoline-range organics—were found in all three borings; maximum concentrations were 950  $\mu\text{g/kg}$ , 900  $\mu\text{g/kg}$ , 8900  $\mu\text{g/kg}$ , and 1700  $\mu\text{g/kg}$ , respectively.

SVOC detections of the fuel-related compounds naphthalene and 2-methylnaphthalene were found in each of the four borings at Site 7; maximum concentrations were 3300  $\mu\text{g/kg}$  and 5100  $\mu\text{g/kg}$ . In three of the borings, these contaminants occurred only in the sample at refusal. Several of the polynuclear aromatic hydrocarbons were also detected at low levels of concentration (see Table 5.12): fluorene, phenanthrene, fluoranthene, and pyrene. The common laboratory contaminants bis(2-ethylhexyl)phthalate and di-n-octylphthalate were also present in borings and in the dry well samples at 7DW-1. Although concentrations are above the "10X blank rule," their presence through laboratory or field contamination may not be precluded.

#### 5.5.2.2 Inorganic Soil Confirmation and Delineation

Four metals were detected at Site 7 that were above the background criteria of average plus two standard deviations discussed in Sect. 5.2: arsenic, copper, lead, and zinc. These data are presented on Table 5.13; maximum concentrations for the four metals were 11.1 mg/kg, 32.1 mg/kg, 17.5 mg/kg, and 68.6 mg/kg. Beryllium and mercury were also detected at Site 7 but were not detected in the background borings. These metals are below or within the range of concentrations found in the western United States (Shacklette 1984).

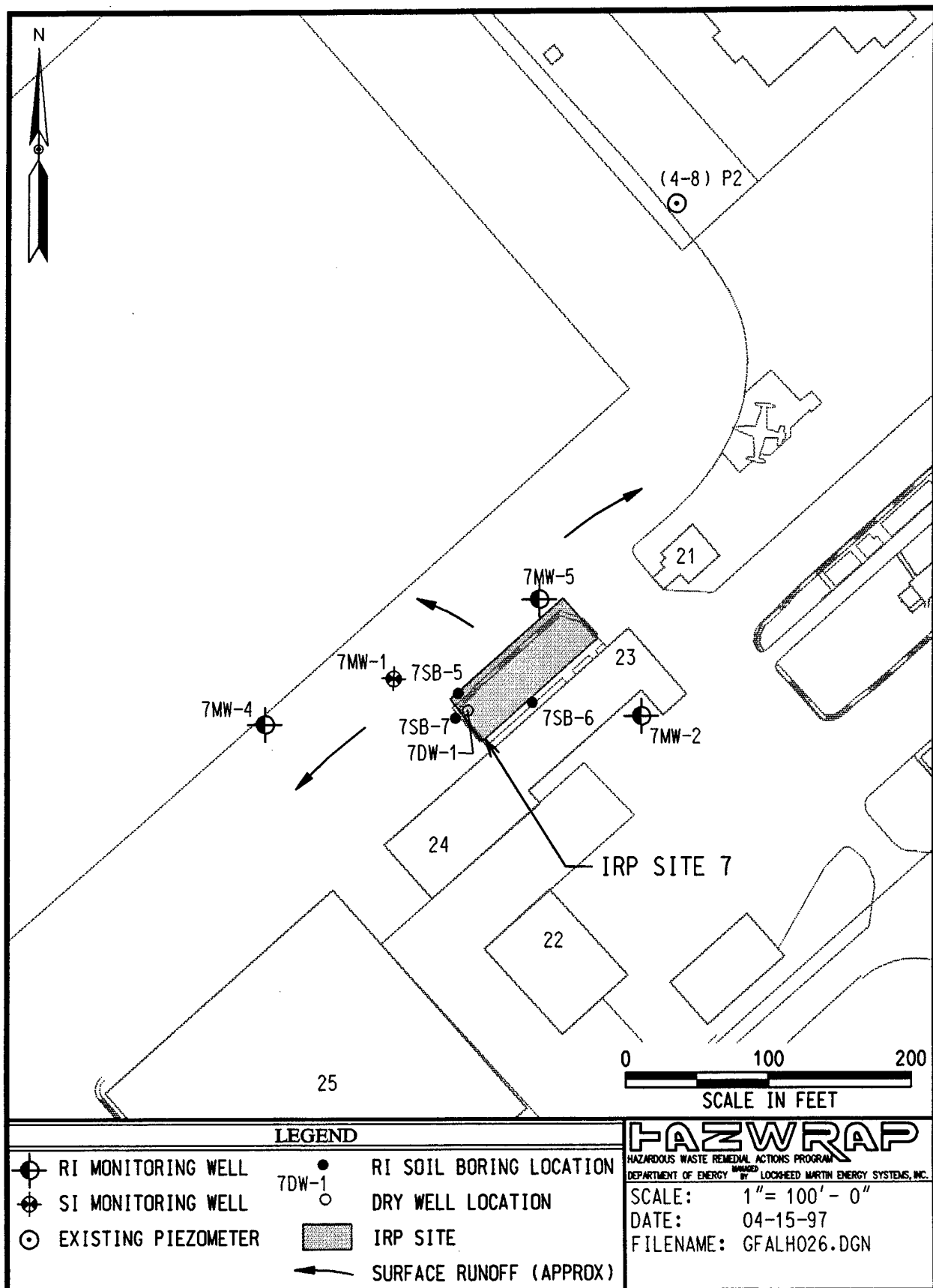


Fig. 5.11. Site 7 Soil Boring Location Map.  
 120th FW Montana Air National Guard, Great Falls, Montana.



Table 5.13. Soil Inorganic Analytical Data - Site 7 - 120th FW, MANG, Great Falls, Montana

SAMPLE INFORMATION		AVG. +/- TWO STD. DEV.	7	7	7	7	7	7
Site	Location		DW1	DW1	SB5	SB5	SB5	SB5
Sample Number			7-DW1-1.2-3.2	7-DW1-3.2-4.2	7-SB5-1-3	7-SB5-4.5-5.4	7-SB5-8-8.6	
Matrix			soil	soil	soil	soil	soil	
Date Sampled			4/27/96	4/27/96	4/27/96	4/27/96	4/27/96	
Date Analyzed			5/8-13/97	5/8-13/97	5/9/96 - 6/14/96	5/9/96 - 6/14/96	5/9/96 - 6/14/96	
ANALYTICAL INFORMATION								
INORGANICS			RESULT	RESULT	RESULT	RESULT	RESULT	
Analyte		1.9 - 9.9	ND	ND	11.1	1.9	3.1	
Arsenic		ND	ND	ND	158	132	390	
Barium		ND - 1231	239	229	0.78	0.33J	0.55J	
Beryllium		ND	ND	ND	ND	7.2	11.3	
Chromium		8.7 - 22.7	19.3	13.1	14.2	16	24.3	
Copper		8.7 - 19.7	18.9	15.1	32.1	17.5	7.7	
Lead		3.4 - 13	8.5	9.4	13.5	17.5	7.7	
Mercury		NE	ND	ND	ND	ND	ND	
Nickel		3.6 - 17.6	16.2	13.5	13.6	7.2	9.5	
Zinc		21.8 - 61.3	45.7	50.8	88.8	55.3	85.3	
Units (mg/kg) Soil, (ug/L) Water								

SAMPLE INFORMATION		AVG. +/- TWO STD. DEV.	7	7	7	7	7	7
Site	Location		SB6	SB6	SB6	SB7	SB7	SB7
Sample Number			7-SB6-0.2	7-SB6-3.5-5.5	7-SB6-7.2-8	7-SB7-1-3	7-SB7-3.4-5.2	7-SB7-8-8.3
Matrix			soil	soil	soil	soil	soil	soil
Date Sampled			4/27/96	4/27/96	4/27/96	4/27/96	4/27/96	4/27/96
Date Analyzed			5/8-13/97	5/8-13/97	5/8-13/97	5/8-13/97	5/8-13/97	5/8-13/97
ANALYTICAL INFORMATION								
INORGANICS			RESULT	RESULT	RESULT	RESULT	RESULT	RESULT
Analyte		1.9 - 9.9	ND	ND	ND	8.9	ND	ND
Arsenic		ND	ND	ND	ND	292	122	729
Barium		ND - 1231	181	167	165	ND	ND	ND
Beryllium		ND	ND	ND	ND	ND	ND	ND
Chromium		8.7 - 22.7	10.7	6.5	10.4	17.5	8.3	10.9
Copper		8.7 - 19.7	19.7	13.1	17	13.9	10.5	13.3
Lead		3.4 - 13	7.5	4.5	11.7	9.3	5.8	9.2
Mercury		NE	ND	ND	ND	ND	ND	ND
Nickel		3.6 - 17.6	10.9	7.8J	9.3J	16.1	9.3	12.1
Zinc		21.8 - 61.3	45.8	36.6	48.2	43.5	41.5	37
Units (mg/kg) Soil, (ug/L) Water								

**Legend**  
MCLs  
MDEQ  
NE  
DW  
SB  
SS  
(DISS)  
CRQL  
RL  
ND  
J  
R  
N

Federal Drinking Water Standard Maximum Contaminant Level  
Montana Department of Environmental Quality Human Health Standards  
ARARs Not Established  
Dry Well  
Soil Boring  
Sediment/Surface Soil  
Dissolved Sample (total metals)  
Concentration > or = MCLs or MDEQ ARARs, or Avg. +2 Standard Dev.  
Contract Required Quantitation Limit  
Reporting Limit  
Compound Not Detected  
Concentration Estimated  
Results Rejected on Basis of Laboratory QA/QC  
Presumptive Evidence of Compound

### 5.5.3 Groundwater Confirmation and Delineation

Although numerous VOC analytes were detected in both rounds of groundwater sampling at Site 7 monitoring wells, only one analyte, benzene, was detected at a level above State or Federal ARARs. This single occurrence was in the first round of sampling of 7MW-2 where benzene was detected at a level of 5.5  $\mu\text{g/L}$  (benzene has a State and Federal MCL of 5  $\mu\text{g/L}$ ). Low levels of other fuel analytes toluene, ethylbenzene, and total xylenes were detected in the three wells sampled. These and other detections are shown on Fig. 5.12 and listed on Tables 5.14 and 5.15. The following chlorinated compounds were also detected: 1,1-dichloroethene, 1,1-dichloroethane, cis-1,2-dichloroethene, 1,1,1-trichloroethane, carbon tetrachloride, TCE, and tetrachloroethene. Other analytes detected were chloromethane, bromodichloromethane, 4-methyl-2-pentanone, styrene, bromoform, 1,4-dichlorobenzene, and 1,2-dibromo-3-chloropropane. Concentrations of acetone, 2-butanone, and 2-hexanone were also detected. Although these detections are greater than ten times the level in associated blanks, their presence as a result of contamination and sampling processes may not be precluded.

Six PAHs were detected at concentrations in excess of both Federal and State ARARs. These compounds and their detected concentrations are benzo[a]anthracene (2  $\mu\text{g/L}$ ), chrysene (2  $\mu\text{g/L}$ ), benzo[b]fluoranthene (2  $\mu\text{g/L}$ ), benzo[k]fluoranthene (2  $\mu\text{g/L}$ ), benzo[a]pyrene (1  $\mu\text{g/L}$ ), and ideno[1,2,3-cd]pyrene (1  $\mu\text{g/L}$ ). Montana Water Quality Standards (Human Health Standards) are 0.044  $\mu\text{g/L}$  for all the above PAHs except benzo[a]pyrene, which is 0.02  $\mu\text{g/L}$ . These and less stringent Federal MCLs are presented in Appendix L. The PAH detections were all qualified concentrations and confined only to the second round of groundwater sampling of monitoring well 7MW-4. The remaining SVOCs detected in the wells are presented on Table 5.14; none of these analytes were above ARARs. Two phthalate compounds, diethyl phthalate and di-n-butylphthalate, were also detected. The presence of these compounds, although above the 10X blank rule, may not preclude laboratory or sampling contaminants.

Low levels of petroleum hydrocarbons were detected in all four monitoring wells; one well, discussed in Sect. 5.4.4, was found to have free product present. JP-4 in the dissolved phase was present at a maximum concentration of 7.7 mg/L, as were diesel- and gasoline-range organics at maximum concentrations of 1.8 mg/L and 1.4 mg/L, respectively.

Eight metals—arsenic, barium, beryllium, chromium, copper, lead, nickel, and zinc—in both dissolved and filtered samples were present in both rounds of groundwater analyses (Table 5.15). None of the inorganic data exceeded Federal or State ARARs. Arsenic, barium, lead, and zinc were found in concentrations exceeding that of the background values presented on Table 5.5.

### 5.5.4 Free Product

During the initial RI field activities, but before drilling and installing the monitoring wells, a free product thickness of 1.32 ft was detected in the existing monitoring well, 7MW-1. Groundwater sampling of the well performed during the SI had detected the presence of fuel-related VOC and SVOC compounds (Table 2.6). The concentrations detected, however, were above MCLs only for benzene (detected at 11  $\mu\text{g/L}$ ) in the first round, and no free product was reported. After the installation of the RI wells and during the measurement of water-level elevations, a reduced thickness of 1.1 ft of product was measured. A sample of the product was collected, and a GC fingerprint analysis for JP-4-range and JP-8-range fuels was performed.

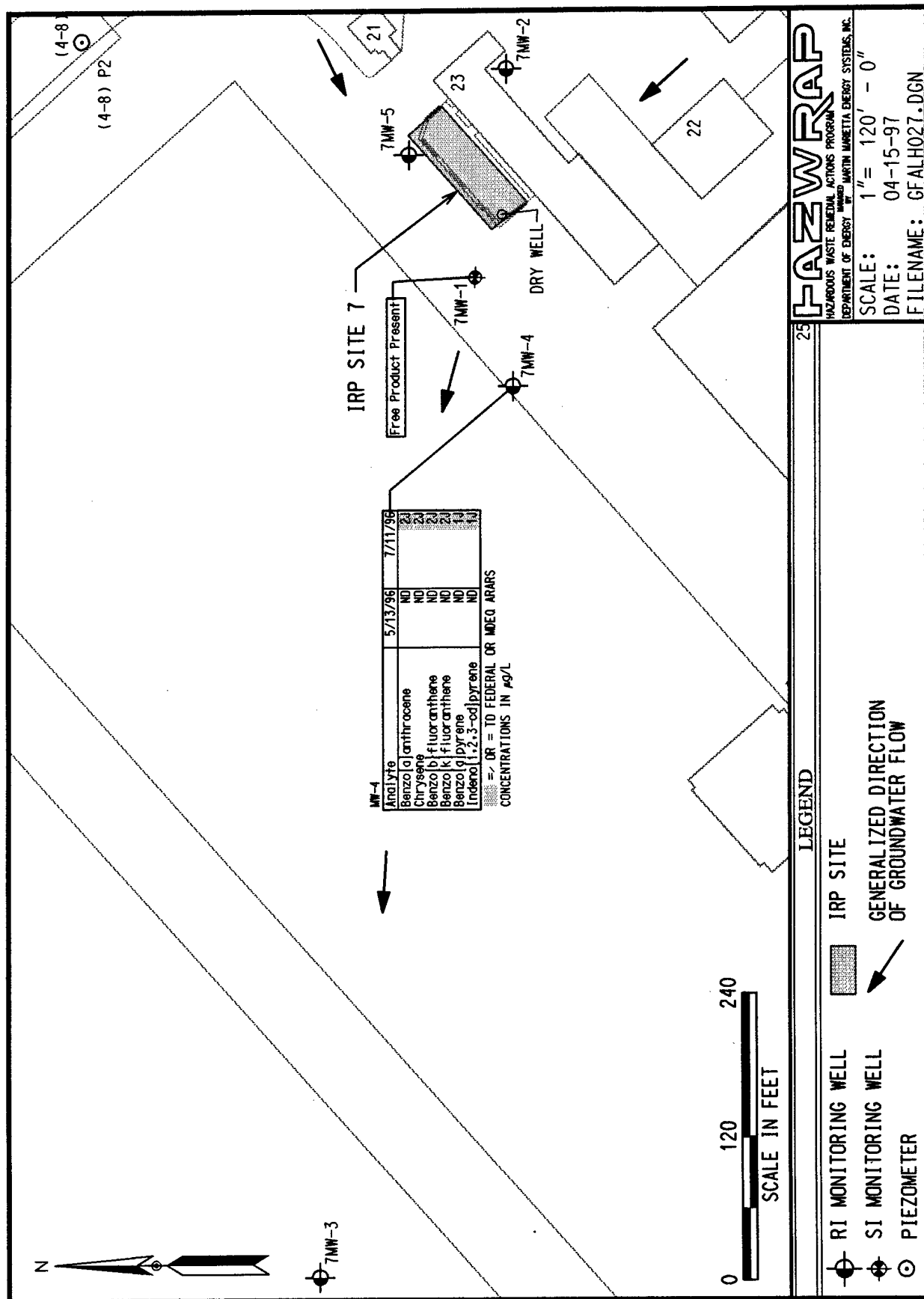


Fig. 5.12. Site 7 Groundwater Monitoring Well Locations and Analytical Data Map.  
120th FW Montana Air National Guard, Great Falls, Montana.







Comparison of these GC runs with standards run for JP-4 and JP-8 indicate a fairly close match to JP-4. Copies of the chromatograms are presented in Appendix K. As a note, JP-8 currently used by the Base, was not used as a fuel at the Base until October 1995.

During the interval between the end of the first round (May 20, 1996) to 1 week before the start of the second round (July 6, 1996) of groundwater sampling, product (and water) was bailed by Base personnel twice a week. The product thickness in the well on July 6, 1996, was determined to be 0.15 ft.

It is suspected this reduced thickness represents more of a slow recharge into the well of product from peripheral areas rather than an absolute reduction in product thickness.

## **5.6 SITE 8 - DRY WELL OFF COMPOSITE MAINTENANCE BUILDING (BUILDING 32)**

### **5.6.1 Soil Screening Results**

PID readings were obtained from the ends of the brass sample liners immediately upon opening the split spoons. The results of the PID screening are included on one of the data entry columns for the boring logs included as Appendix B.

### **5.6.2 Soil Confirmation and Delineation**

A total of five soil borings plus one duplicate were drilled and sampled during the SI. These borings confirmed the presence of relatively low concentrations of fuel and chlorinated compounds in the soil at the site. The location of the SI borings is shown on Fig. 2.5, and a summary of the data is presented in Table 2.7. The location of the five RI soil borings were intended to further delineate the vertical and areal extent of the contamination. Because of the numerous underground utilities present at the site, boring locations were shifted from those originally planned in the RI WP.

#### **5.6.2.1 Volatile and Semivolatile Organic Compound Confirmation and Delineation**

Low levels of fuel and other VOC compounds were detected in the five borings advanced during the RI; only one of the soil borings, SB-8, appeared to have contamination on the same order of magnitude as found during the SI. Boring locations are presented on Fig. 5.13 and the data in Tables 5.16 and 5.17. Fuel components toluene were found in SB-8, SB-9, and SB-10 with a qualified maximum concentration of 420  $\mu\text{g/kg}$ , ethylbenzene in SB-7 and SB-8 with a qualified maximum concentration of 250  $\mu\text{g/kg}$ , and total xylenes in all five borings up to a maximum concentration of 1900  $\mu\text{g/kg}$ . The chlorinated compound 1,1,2-trichloroethane was detected in only one boring, SB-6, at a maximum qualified concentration of 1  $\mu\text{g/kg}$ ; 1,2-dichloroethene was detected only in SB-8 with a maximum qualified concentration of 86  $\mu\text{g/kg}$ . These levels of contamination were significantly lower than levels found during the SI at SB-4. Two other VOC compounds, carbon disulfide and 4-methyl-2-pentanone, were present in SB-7, SB-8, and SB-9; maximum detections were a qualified 1  $\mu\text{g/kg}$  and 25  $\mu\text{g/kg}$ , respectively. Both compounds were found in the shallower sampling depths and were not detected in the sample collected at refusal.

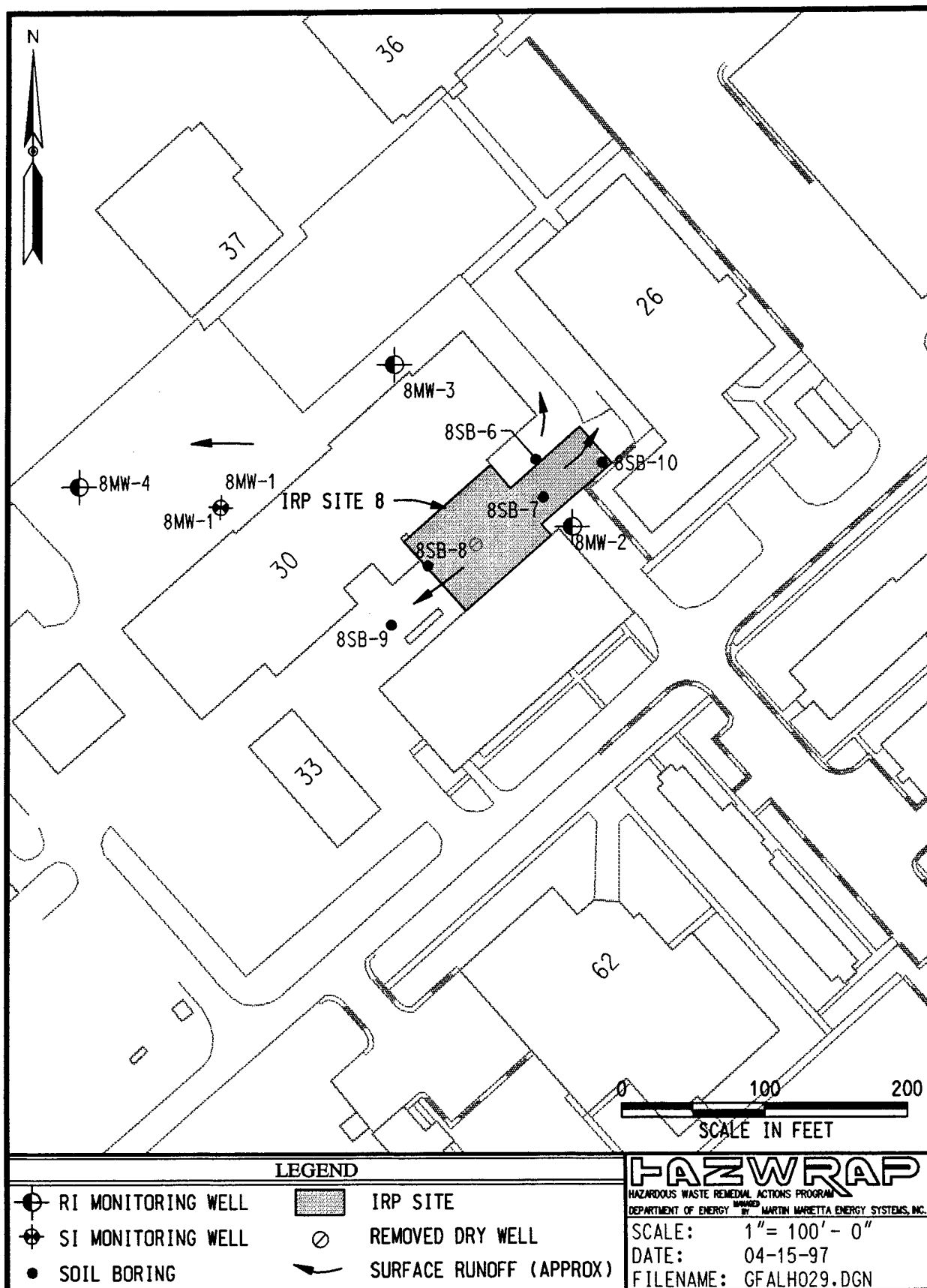


Fig. 5.13. Site 8, Soil Boring Location Map.  
 120 FW Montana Air National Guard, Great Falls, Montana.

Table 5.16. Soils Organic Analytical Data - Site 8 - 120th FW MANG, Great Falls, Montana

SAMPLE INFORMATION		SB6	SB6	SB6	SB6	SB7	Diluted Sample	SB7	SB7	SB7	SB8	Diluted Sample	SB8	SB8
Location		0.5-2.4 ft	4.5-5.7 ft	9.5-10.3 ft	0.5-2.5 ft	0.5-2.5 ft	0.5-2.5 ft	0.5-2.5 ft	4.5-5.8 ft	8.9-10.3 ft	0.5-2.5 ft	4.5-5.5 ft	4.5-5.5 ft	9.5-10.5 ft
Depth		8-SB6-0.5-2.5	8-SB6-4.5-5.7	8-SB6-8.9-10.3	8-SB70.5-2.5	8-SB70.5-2.5	8-SB70.5-2.5	8-SB70.5-2.5	8-SB7-4.5-5.8	8-SB7-8.9-10.3	8-SB8-0.5-2.5	8-SB8-4.5-5.5	8-SB8-4.5-5.5	8-SB8-9.5-10.5
Sample Number		Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Matrix		4/25/96	4/25/96	4/25/96	4/25/96	4/25/96	4/25/96	4/25/96	4/25/96	4/25/96	4/25/96	4/25/96	4/25/96	4/25/96
Date Sampled														
ANALYTICAL INFORMATION														
VOCs														
Date Analyzed		5/3/96	4/30/96	5/3/96	4/30/96	5/3/96	5/3/96	5/3/96	5/3/96	5/3/96	4/30/96	4/30/96	5/7/96	5/2/96
Analyte	CRQL	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
Acetone	10	610J	ND	130J	390	1J	ND	950J	200J	130J	140J	540J	910J	820J
Carbon Disulfide	10	ND	1J	ND	1J	ND	ND	ND	1J	ND	1J	1J	ND	ND
Methylene Chloride	10	ND	2BJ	ND	ND	ND	ND	ND	ND	ND	ND	ND	90J	77J
2-Butanone	10	33	2J	6J	12	12	93	ND	ND	11J	23	10J	ND	ND
4-Methyl-2-Pentanone	10	ND	ND	ND	25	14J	ND	14J	1J	ND	22	1J	ND	ND
Toluene	10	ND	ND	ND	ND	ND	ND	ND	1J	ND	1J	1J	ND	420J
1,1,2-Trichloroethane	10	ND	1J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	10	2J	ND	4J	5J	18J	ND	18J	1J	5J	11J	11	ND	ND
Ethylbenzene	10	ND	ND	ND	ND	ND	ND	ND	1J	ND	ND	ND	ND	250J
1,2-Dichloroethane	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	5J	9J	ND	86J
Xylene	10	2J	ND	1J	1J	4J	4J	4J	4J	1J	1J	1J	ND	1900
Units		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
SVOCs														
Date Analyzed		5/14/96	5/13/96	5/13/96	5/21/96	5/14/96	5/14/96	5/14/96	5/14/96	5/14/96	5/13/96	5/13/96	5/13/96	5/13/96
Analyte	CRQL	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
Naphthalene	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	380J
2-Methylnaphthalene	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	220J
Di-n-butylphthalate	330	ND	ND	ND	ND	ND	ND	ND	ND	ND	17J	ND	ND	26J
bis(2-Ethylhexyl)phthalate	330	55J	ND	140J	96J	ND	ND	ND	ND	190J	980	ND	ND	100J
Di-n-octylphthalate	330	ND	ND	12J	ND	ND	ND	ND	ND	14J	ND	ND	ND	ND
Units		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Date Analyzed		5/9/96	5/9/96	5/9/96	5/9/96	5/9/96	5/9/96	5/9/96	5/9/96	5/8/96	5/9/96	6/9/96	5/9/96	5/9/96
Petroleum Hydrocarbons	RL	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
JP-4	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	240
Diesel Range, as diesel	100	ND	ND	ND	55NJ	ND	ND	ND	ND	ND	ND	ND	ND	340
Oil Range, as oil	100	15	ND	ND	1700	ND	ND	ND	ND	ND	ND	ND	ND	260NJ
Gasoline Range	5	180	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1200
Units		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Legend														
Federal Drinking Water Standard Maximum Contaminant Level														
Montana Department of Environmental Quality Human Health Standards														
ARAs Not Established														
Dry Well														
Soil Boring														
Sediment/Surface Soil														
Dissolved Sample (total metals)														
(DISS)														
Concentration > or = MCLs OR MEDQ, ARARs, or Avgs + 2 Standard Dev.														
Contract Required Quantitation Limit														
Reporting Limit														
Compound Not Detected														
Concentration Estimated														
Results Rejected on Basis of Laboratory QA/QC														
Presumptive Evidence of Compound														
CRQL														
RL														
ND														
J														
R														
N														

Table 5.16. Soils Organic Analytical Data - Site 8 - 120th FW MANG, Great Falls, Montana (cont)

SAMPLE INFORMATION		SB9	SB9	SB9	SB10	SB10	SB10	SB10
Location		1-3 ft	4.5-5.5 ft	8.5-9.4 ft	1-3 ft	4.5-6.5 ft	4.5-6.5 ft	9.9 ft
Depth		8-SB9-1-3	8-SB9-4.5-5.5	8-SB9-8.5-9.4	8-SB10-1-3	8-SB10-4.5-6.5	8-SB10-4.5-6.5DL	8-SB10-9.9
Sample Number		Soil	Soil	Soil	Soil	Soil	Soil	Soil
Matrix		4/30/96	4/30/96	4/30/96	4/30/96	4/30/96	4/30/96	4/30/96
Date Sampled								
ANALYTICAL INFORMATION								
VOCs								
Date Analyzed		5/3/96	5/6/96	5/6/96	5/6/96	5/6/96	5/7/96	5/6/96
Analyte	CRQL	Result	Result	Result	Result	Result	Result	Result
Acetone	10	28	82	93	210	490J	900J	160
Carbon Disulfide	10	ND	ND	1J	1J	ND	ND	ND
2-Butanone	10	4J	ND	8J	2J	2J	ND	10J
4-Methyl-2-Pentanone	10	6J	ND	ND	ND	ND	ND	ND
Toluene	10	ND	1J	1J	1J	1J	ND	1J
2-Hexanone	10	4J	ND	2J	ND	ND	ND	ND
Xylene	10	ND	1J	ND	ND	1J	ND	1J
Units	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
SVOCs								
Date Analyzed		5/15/96	5/15/96	5/15/96	5/16/96	5/16/96		5/16/96
Analyte	CRQL	Result	Result	Result	Result	Result		Result
Bis(2-Ethylhexyl)phthalate	330	200J	190J	ND	ND	ND		ND
Di-n-Octylphthalate	330	6J	14J	ND	ND	ND		ND
Units	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg		ug/kg
Date Analyzed		5/17/96	5/17/96	5/17/96	5/17/96	5/18/96		5/17/96
Petroleum Hydrocarbons	CRQL	Result	Result	Result	Result	Result		Result
JP-4, Diesel-Oil-Gasoline Range: ND	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg		mg/kg
RL 10, 10, 100, 5 mg/kg, respectively	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg		mg/kg
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg		mg/kg
Legend		Federal Drinking Water Standard Maximum Contaminant Level						
MCLs		Montana Department of Environmental Quality Human Health Standards						
MDEQ		ARAs Not Established						
NE		Dry Well						
DW		Soil Boring						
SB		Sediment/Surface Soil						
SS		Dissolved Sample (total metals)						
(DISS)		Concentration > or = MCLs OR MEDQ, ARARs, or Ave + 2 Standard Dev.						
		Contract Required Quantitation Limit						
CRQL		Reporting Limit						
RL		Compound Not Detected						
ND		Concentration Estimated						
J		Results Rejected on Basis of Laboratory QA/QC						
R		Presumptive Evidence of Compound						
N								

Table 5.17. Soil Inorganic Analytical Data - Site 8 - 120th FW, MANG, Great Falls, Montana

SAMPLE INFORMATION		AVG. ±1. TWO STD. DEV.		8		8		8		8		8		8	
Site															
Location															
Sample Number															
Matrix															
Date Sampled															
Date Analyzed															
ANALYTICAL INFORMATION															
INORGANICS															
Analyte															
Arsenic	1.9 - 9.9	8.6	3.3	8.6	3.3	8.6	3.3	8.6	3.3	8.6	3.3	8.6	3.3	8.6	3.3
Barium	ND - 1231	358	78.3	358	78.3	358	78.3	358	78.3	358	78.3	358	78.3	358	78.3
Beryllium	NE	0.52J	ND	0.52J	ND	0.52J	ND	0.52J	ND	0.52J	ND	0.52J	ND	0.52J	ND
Cadmium	NE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	8.7 - 22.7	15.3	7.8	15.3	7.8	15.3	7.8	15.3	7.8	15.3	7.8	15.3	7.8	15.3	7.8
Copper	8.7 - 19.7	37.4	11.1	37.4	11.1	37.4	11.1	37.4	11.1	37.4	11.1	37.4	11.1	37.4	11.1
Lead	3.4 - 13	8.1	5.9	8.1	5.9	8.1	5.9	8.1	5.9	8.1	5.9	8.1	5.9	8.1	5.9
Mercury	NE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	3.6 - 17.6	11.9	8.6	11.9	8.6	11.9	8.6	11.9	8.6	11.9	8.6	11.9	8.6	11.9	8.6
Selenium	ND - 0.66	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	NE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	21.6 - 61.3	52.7	47.5	52.7	47.5	52.7	47.5	52.7	47.5	52.7	47.5	52.7	47.5	52.7	47.5
Units (mg/kg) Sol. (ug/L) Water															

SAMPLE INFORMATION		AVG. ±1. TWO STD. DEV.		8		8		8		8		8		8	
Site															
Location															
Sample Number															
Matrix															
Date Sampled															
Date Analyzed															
ANALYTICAL INFORMATION															
INORGANICS															
Analyte															
Arsenic	1.9 - 9.9	8.6	3.3	8.6	3.3	8.6	3.3	8.6	3.3	8.6	3.3	8.6	3.3	8.6	3.3
Barium	ND - 1231	358	78.3	358	78.3	358	78.3	358	78.3	358	78.3	358	78.3	358	78.3
Beryllium	NE	0.52J	ND	0.52J	ND	0.52J	ND	0.52J	ND	0.52J	ND	0.52J	ND	0.52J	ND
Cadmium	NE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	8.7 - 22.7	15.3	7.8	15.3	7.8	15.3	7.8	15.3	7.8	15.3	7.8	15.3	7.8	15.3	7.8
Copper	8.7 - 19.7	37.4	11.1	37.4	11.1	37.4	11.1	37.4	11.1	37.4	11.1	37.4	11.1	37.4	11.1
Lead	3.4 - 13	8.1	5.9	8.1	5.9	8.1	5.9	8.1	5.9	8.1	5.9	8.1	5.9	8.1	5.9
Mercury	NE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	3.6 - 17.6	11.9	8.6	11.9	8.6	11.9	8.6	11.9	8.6	11.9	8.6	11.9	8.6	11.9	8.6
Selenium	ND - 0.66	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	NE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	21.6 - 61.3	52.7	47.5	52.7	47.5	52.7	47.5	52.7	47.5	52.7	47.5	52.7	47.5	52.7	47.5
Units (mg/kg) Sol. (ug/L) Water															

Legend  
 MCIs Federal Drinking Water Standard Maximum Contaminant Level  
 MDEQ Montana Department of Environmental Quality Human Health Standards  
 NE ARAs Not Established  
 DW Dry Well  
 SB Soil Boring  
 SS Sediment/Surface Soil  
 (DISS) Dissolved Sample (total metals)  
 Concentration > or = MCLs OR MDEQ, ARAs, or Avg ± 2 Standard Dev.  
 CRQL Contract Required Quantitation Limit  
 RL Reporting Limit  
 ND Compound Not Detected  
 J Concentration Estimated  
 R Results Reported on Basis of Laboratory QA/QC  
 R Presumptive Evidence of Compound

Several common laboratory and sampling contaminants were reported as detectable concentrations following data validation and application of the 10X blank rule: acetone and 2-butanone were found in every boring, methylene chloride was found in SB-8, and 2-hexanone was present in each boring except SB-10.

Petroleum hydrocarbon detections were found in three borings: SB-6, SB-7, and SB-8. The detections included diesel-, gasoline- and oil-range compounds at maximum concentrations of 340 mg/kg, 1200 mg/kg, and 1700 mg/kg, respectively.

SVOC detections consisted of the fuel-associated compounds naphthalene and 2-methylnaphthalene and several of the phthalate compounds. Naphthalene and 2-methylnaphthalene were only present in the sample collected at refusal in SB-8 at a qualified 380  $\mu\text{g/kg}$  and 220  $\mu\text{g/kg}$ , respectively. Phthalates present were identified as di-n-butylphthalate, bis(2-ethylhexyl)phthalate, and di-n-octylphthalate (see Table 5-16). Although these contaminants were above the 10X blank rule, their detection because of laboratory or sampling processes may not be precluded.

#### 5.6.2.2 Inorganic Soil Compound Confirmation and Delineation

Concentrations above the background average plus two standard deviations were detected for arsenic (up to 22.4 mg/kg), copper (up to 37.4 mg/kg), lead (up to 17.2 kg), and zinc (up to 137 mg/kg) in Site 8 soils (Table 5.17). Beryllium, cadmium, and mercury were also detected but were not present in the background samples. These detections are below or within the range for metals for the western United States presented in Sect. 5.2.

#### 5.6.3 Groundwater Confirmation and Delineation

Results from the two rounds of groundwater sampling at Site 8 indicated the presence of a variety of chlorinated compounds, some of which were above State and Federal MCLs in all four wells. Other VOCs were present, but only low-level detections of fuel-related analytes and petroleum hydrocarbons were found; SVOCs were either absent or restricted to suspected laboratory contaminants diethylphthalate and di-n-butyl phthalate. Figure 5.14 and Tables 5.18 and 5.19 present the analytical results.

Concentrations of cis-1,2-dichloroethene were detected in all four Site 8 wells and in both rounds of groundwater sampling; detections ranged from a low of 2.3  $\mu\text{g/L}$  (8MW-2) to a maximum of 830  $\mu\text{g/L}$  (8MW-1). In three of the four wells the concentrations were above State and Federal MCLs of 70  $\mu\text{g/L}$ . TCE was also detected in each of the four wells and at concentrations above State and Federal MCLs of 5  $\mu\text{g/L}$  in the same three wells. The maximum TCE concentrations was a qualified 55  $\mu\text{g/L}$ . Tetrachloroethene was present in three wells and above MCLs (5  $\mu\text{g/L}$ ) in two; maximum concentration detected was 18  $\mu\text{g/L}$ . Results from the SI sampling of groundwater indicated the presence of TCE and 1,2-dichloroethene above ARARs and four other chlorinated compounds. Numerous low-level concentrations, all below ARARs, of other chlorinated compounds were detected during the RI sampling and included detections of chloromethane, 1,1-dichloroethene, trans-1,2-dichloroethene, 1,1-dichloroethane, chloroform, vinyl chloride, 1,2-dichloroethane, 1,1,1-trichloroethane, carbon tetrachloride, 1,1,2-trichloroethane, chlorobenzene, 1,4-dichlorobenzene, and 1,2-dibromo-3-chloropropane (quantitative value rejected for a quality control problem or matrix interferences).

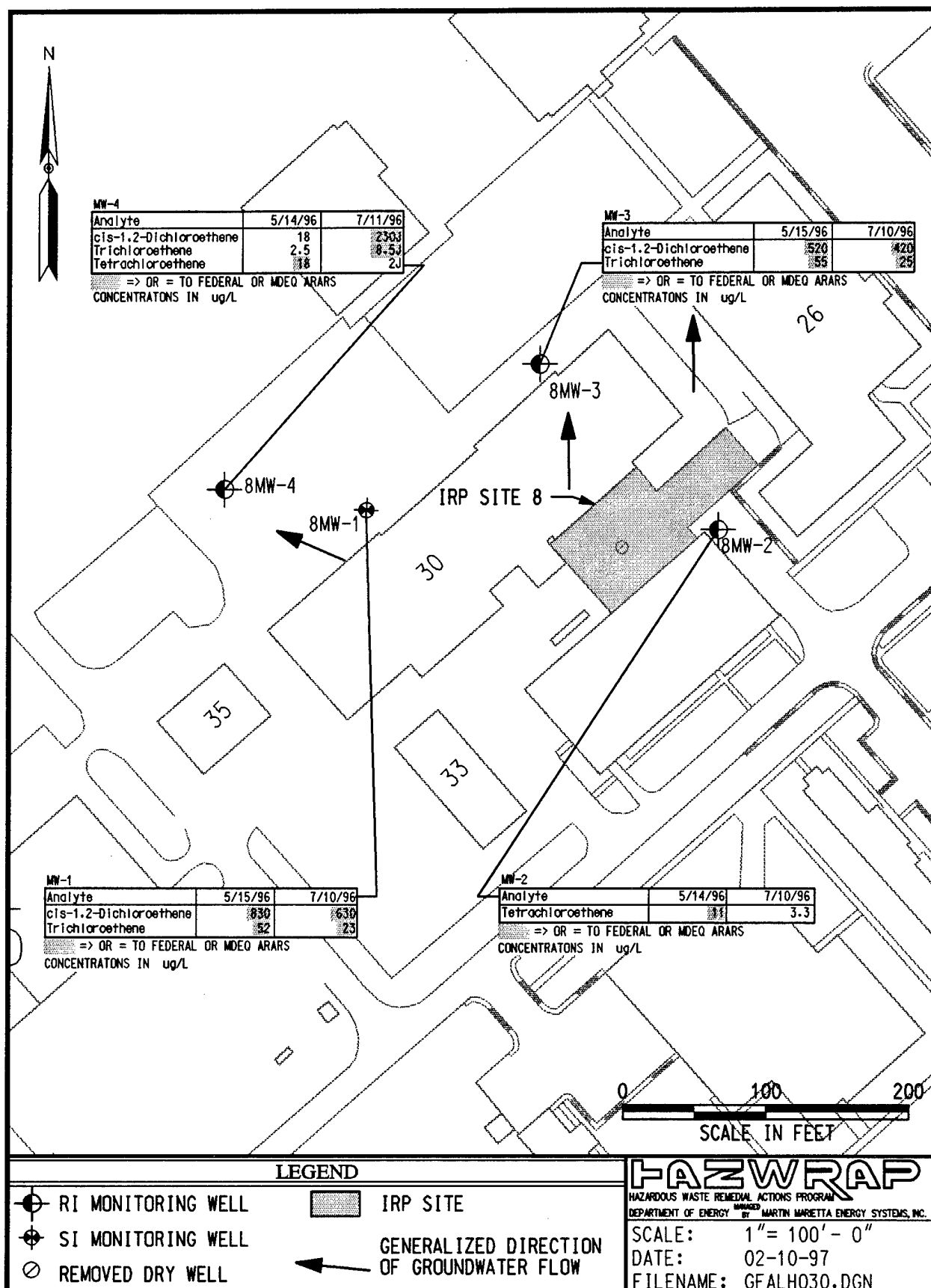


Fig. 5.14. Site 8, Groundwater Monitoring Well Location and Analytical Data Map.  
120 FW Montana Air National Guard, Great Falls, Montana.

Table 5.18. Groundwater Organic Analyses - Site 8 - 120th FW, MANG, Great Falls, Montana

SAMPLE INFORMATION				Diluted Sample		Diluted Sample		Diluted Sample		Field Duplicate	
Site	Monitoring Well	Sample Number	Matrix	8	8	8	8	8	8	8	8
				MW-1	MW-1	MW-1	MW-1	MW-2	MW-2	MW-2	MW-2
				8-MW1-GW1	8-MW1-GW1DL	8-MW1-GW2	8-MW1-GW2DL	8-MW2-GW1	8-MW2-GW2	8-MW2-GW2	8-MW2-GW2
				Water	Water	Water	Water	Water	Water	Water	Water
				5/15/96	5/15/96	7/10/96	7/10/96	5/14/96	7/10/96	7/10/96	7/10/96
				5/16/96	5/17/96	7/17/96	7/23/96	5/24/96	7/18/96	7/17/96	7/17/96
ANALYTICAL INFORMATION				Diluted Sample		Diluted Sample		Diluted Sample		Field Duplicate	
VOCs	CRQL	MCLs	MDEQ	8	8	8	8	8	8	8	8
Chloromethane	1	NE	NE	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	1	7	5.7	2.1	ND	1.5	ND	0.64J	0.43J	0.41J	0.41J
Acetone	1	NE	NE	R	R	R	R	R	R	R	R
trans-1,2-Dichloroethene	1	100	100	0.63J	ND	0.15J	ND	ND	ND	ND	ND
1,1-Dichloroethane	1	NE	NE	16	14J	9.6	12J	0.3J	0.24J	0.23J	0.23J
cis-1,2-Dichloroethene	1	70	70	290J	830	340J	630	4.9	2.6	2.3	2.3
2-Butanone	5	NE	NE	R	R	R	R	R	R	R	R
Chloroform	1	100	57	0.9J	ND	0.95J	ND	1.3	0.87J	0.78J	0.78J
1,2-Dichloroethane	1	5	3.8	0.86J	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	1	200	200	4.5	ND	2.9	ND	0.74J	0.68J	0.58J	0.58J
Carbon Tetrachloride	1	5	2.5	0.49J	ND	0.33J	ND	ND	ND	ND	ND
Trichloroethene	1	5	5	55J	82	23	ND	3	1.2	1	1
Toluene	1	1000	1000	ND	ND	1.6	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	1	5	5	0.42J	ND	0.13J	ND	ND	ND	ND	ND
Tetrachloroethene	1	5	5	1.8	ND	2.4	ND	1.1	3.3	3	3
2-Hexanone	5	NE	NE	ND	ND	R	R	ND	R	R	R
Chlorobenzene	1	100	20	ND	ND	0.1J	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	1	75	75	ND	ND	0.98J	ND	ND	0.85J	0.77J	0.77J
1,2-Dibromo-3-chloropropane	1	0.2	0.2	R	R	ND	ND	R	ND	ND	ND
Units	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Sample Number				8-MW1-GW1	8-MW1-GW2	8-MW1-GW2	8-MW1-GW2	8-MW2-GW1	8-MW2-GW2	8-MW2-GW2	8-MW2-GW2
Date Sampled				5/15/96	5/15/96	7/10/96	7/10/96	5/14/96	7/10/96	7/10/96	7/10/96
Date Analyzed				5/24/96	5/24/96	7/23/96	7/23/96	5/24/96	7/23/96	7/23/96	7/23/96
SVOCs	CRQL	MCLs	MDEQ	8	8	8	8	8	8	8	8
Analyte	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Units	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Date Sampled				5/15/96	5/15/96	7/10/96	7/10/96	5/14/96	7/10/96	7/10/96	7/10/96
Date Analyzed				5/17/96	5/17/96	7/17/96	7/17/96	5/17/96	7/17/96	7/17/96	7/17/96
Petroleum Hydrocarbons	RL	MCLs	MDEQ	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Diesel range, as diesel	NE	NE	NE	ND	ND	ND	ND	ND	ND	ND	ND
Units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Legend				Federal Drinking Water Standard Maximum Contaminant Level							
MCLs				Montana Department of Environmental Quality Human Health Standards							
MDEQ				ARAs Not Established							
NE				Dry Well							
DW				Sediment/Surface Soil							
SB				Dissolved Sample (total metals)							
SS				Concentration > or = MCLs OR MDEQ, ARA, or Ave + 2 Standard Dev.							
(DISS)				Contract Required Quantitation Limit							
CRQL				Reporting Limit							
RL				Compound Not Detected							
ND				Concentration Estimated							
J				Results Rejected on Basis of Laboratory QA/QC							
R				Presumptive Evidence of Compound							
N											



Table 5.18. Groundwater Organic Analyses - Site 8 - 120th FW, MANG, Great Falls, Montana (cont)

SAMPLE INFORMATION				Diluted Sample		Diluted Sample		Diluted Sample		Diluted Sample	
Site	Monitoring Well	Sample Number	Matrix	8	8	8	8	8	8	8	8
				MW-3	MW-3	MW-3	MW-3	MW-4	MW-4	MW-4	MW-4
				8-MW3-GW1	8-MW3-GW1DL	8-MW3-GW2	8-MW3-GW2DL	8-MW4-GW1	8-MW4-GW1DL	8-MW4-GW2	8-MW4-GW2DL
				Water	Water	Water	Water	Water	Water	Water	Water
				5/15/98	5/17/98	7/10/98	7/10/98	5/14/98	5/14/98	7/11/98	7/11/98
				5/18/98	7/17/98	7/17/98	7/17/98	5/15/98	5/15/98	7/23/98	7/23/98
ANALYTICAL INFORMATION				Diluted Sample		Diluted Sample		Diluted Sample		Diluted Sample	
VOCs				8	8	8	8	8	8	8	8
Analyte	CRQL	MCLs	MDEQ	Result	Result	Result	Result	Result	Result	Result	Result
Chloromethane	1	NE	NE	ND	ND	ND	ND	ND	ND	0.17J	ND
Vinyl Chloride	1	2	2	0.26J	ND	0.26J	ND	ND	ND	ND	ND
1,1-Dichloroethane	1	7	5.7	3.6	ND	3.1	2.2J	0.87J	0.54J	0.59J	ND
Acetone	1	NE	NE	R	R	R	R	R	R	R	R
trans-1,2-Dichloroethane	1	100	100	0.34J	ND	0.31J	ND	ND	ND	0.1J	ND
1,1-Dichloroethane	1	NE	NE	10	ND	12	9.4J	0.85J	0.82J	5.3J	4.2J
cis-1,2-Dichloroethane	1	70	70	340J	ND	340J	400	28J	18	230J	220J
2-Butanone	5	NE	NE	R	R	R	R	R	R	R	R
Chloroform	1	100	57	4.3	ND	3.4	3J	2.7	1.9J	1.8J	ND
1,2-Dichloroethane	1	5	3.8	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	1	200	200	5J	5.5J	3.9	3.4J	0.97J	0.84J	1.2J	ND
Carbon Tetrachloride	1	5	2.5	0.77J	ND	0.35J	ND	ND	ND	0.18J	ND
Benzene	1	5	5	0.12J	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	1	5	5	46J	55	31J	25	2.5	2J	8.6J	7.4J
Bromochloromethane	1	100	5.6	0.28J	ND	1.3	ND	0.32J	ND	0.15J	ND
Toluene	1	1,000	1,000	ND	ND	ND	ND	ND	ND	2.3J	ND
1,1,2-Trichloroethane	1	5	5	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	1	5	5	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	1	5	5	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	5	NE	NE	ND	ND	R	R	16	17J	2J	ND
1,4-Dichlorobenzene	1	75	75	ND	ND	0.79J	2.3J	ND	ND	1.2J	ND
1,2-Dibromo-3-chloropropane	1	0.2	0.2	R	R	ND	ND	R	R	ND	ND
Units	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
SVOCs				Diluted Sample		Diluted Sample		Diluted Sample		Diluted Sample	
Sample Number	Date Sampled	Date Analyzed	SVOCs	8-MW3-GW1	8-MW3-GW2	8-MW3-GW1	8-MW3-GW2	8-MW4-GW1	8-MW4-GW2	8-MW4-GW1	8-MW4-GW2
				5/15/98	7/10/98	5/14/98	7/10/98	5/14/98	7/10/98	5/14/98	7/10/98
				5/24/98	7/23/98	5/23/98	7/23/98	5/23/98	7/23/98	5/23/98	7/23/98
Analyte	CRQL	MCLs	MDEQ	Result	Result	Result	Result	Result	Result	Result	Result
Diethylphthalate	10	NE	23,000	1J	ND	ND	ND	ND	ND	1J	ND
D-n-butylphthalate	10	NE	2,700	ND	ND	ND	ND	ND	ND	ND	ND
Units	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Pesticides				Diluted Sample		Diluted Sample		Diluted Sample		Diluted Sample	
Date Sampled	Date Analyzed	JP-4	JP-4	5/15/98	7/10/98	5/17/98	7/17/98	5/17/98	7/17/98	5/17/98	7/17/98
				5/17/98	7/17/98	5/17/98	7/17/98	5/17/98	7/17/98	5/17/98	7/17/98
Analyte	CRQL	MCLs	MDEQ	Result	Result	Result	Result	Result	Result	Result	Result
Petroleum Hydrocarbons	RL	MCLs	MDEQ	ND	ND	ND	ND	ND	ND	ND	ND
JP-4	0.25	NE	NE	ND	ND	ND	ND	ND	ND	ND	ND
Gasoline range, as diesel	0.25	NE	NE	ND	ND	ND	ND	ND	ND	ND	ND
Gasoline range	0.25	NE	NE	ND	ND	ND	ND	ND	ND	ND	ND
Units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l

Legend

Federal Drinking Water Standard Maximum Contaminant Level  
Montana Department of Environmental Quality Human Health Standards  
ARAs Not Established  
Dry Well  
Soil Boring  
Sediment/Surface Soil  
Dissolved Sample (total metals)  
Concentration > or = MCLs OR MDEQ, ARAs, or Avge + 2 Standard Dev.

CRQL  
RL  
ND  
J  
R  
N

Table 5.19. Groundwater Inorganic Analytical Data - Site 8 - 120th FW, MANG, Great Falls, Montana

SAMPLE INFORMATION									
Site	8	8	8	8	8	8	8	8	8
Monitoring Well	MW1	MW1	MW1	MW1	MW1	MW1	MW1	MW1	MW1
Sample Number	8-MW1-GW1 (Diss.)	8-MW1-GW1	8-MW1-GW2 (Diss.)	8-MW1-GW2	8-MW1-GW2 (Diss.)	8-MW1-GW2	8-MW1-GW2 (Diss.)	8-MW1-GW2	8-MW1-GW2
Matrix	water	water	water	water	water	water	water	water	water
Date Sampled	5/15/06	5/15/06	7/10/06	7/10/06	7/10/06	7/10/06	7/10/06	7/10/06	7/10/06
Date Analyzed	5/24/06 - 6/4/06	5/24/06 - 6/4/06	7/17-24/06	7/17-24/06	7/17-24/06	7/17-24/06	7/17-24/06	7/17-24/06	7/17-24/06
ANALYTICAL INFORMATION									
INORGANICS									
Analyte	CRDL	MCLs	MDEQ	Result	Result	Result	Result	Result	Result
Ammony	6	6	6	ND	ND	ND	ND	ND	ND
Arsonic	10	50	18	ND	ND	ND	ND	ND	ND
Barium	200	2000	1000	37.6J	99.7J	ND	ND	ND	ND
Beryllium	4	4	40	ND	ND	ND	ND	ND	ND
Chromium	10	100	1000	ND	ND	ND	ND	ND	ND
Copper	25	1300*	1000	ND	ND	ND	ND	ND	ND
Lead	5	15	15	ND	ND	ND	ND	ND	ND
Manganese	0.2	2	0.1	ND	ND	ND	ND	ND	ND
Nickel	40	100	100	ND	ND	ND	ND	ND	ND
Selenium	5	50	50	ND	ND	ND	ND	ND	ND
Zinc	20	NE	5000	ND	ND	ND	ND	ND	ND
Units (mg/L) Sol. (ug/L) Water									

SAMPLE INFORMATION									
Site	8	8	8	8	8	8	8	8	8
Monitoring Well	MW3	MW3	MW3	MW3	MW3	MW3	MW3	MW3	MW3
Sample Number	8-MW3-GW1 (Diss.)	8-MW3-GW1	8-MW3-GW2 (Diss.)	8-MW3-GW2	8-MW3-GW2 (Diss.)	8-MW3-GW2	8-MW3-GW2 (Diss.)	8-MW3-GW2	8-MW3-GW2
Matrix	water	water	water	water	water	water	water	water	water
Date Sampled	5/15/06	5/15/06	7/10/06	7/10/06	7/10/06	7/10/06	7/10/06	7/10/06	7/10/06
Date Analyzed	5/24/06 - 6/4/06	5/24/06 - 6/4/06	7/17-24/06	7/17-24/06	7/17-24/06	7/17-24/06	7/17-24/06	7/17-24/06	7/17-24/06
ANALYTICAL INFORMATION									
INORGANICS									
Analyte	CRDL	MCLs	MDEQ	Result	Result	Result	Result	Result	Result
Ammony	6	6	6	ND	ND	ND	ND	ND	ND
Arsonic	10	50	18	ND	ND	ND	ND	ND	ND
Barium	200	2000	1000	187J	ND	ND	ND	ND	ND
Beryllium	4	4	40	ND	ND	ND	ND	ND	ND
Chromium	10	100	1000	ND	ND	ND	ND	ND	ND
Copper	25	1300*	1000	4.6J	ND	ND	ND	ND	ND
Lead	5	15	15	ND	ND	ND	ND	ND	ND
Manganese	0.2	2	0.1	ND	ND	ND	ND	ND	ND
Nickel	40	100	100	ND	ND	ND	ND	ND	ND
Selenium	5	50	50	ND	ND	ND	ND	ND	ND
Zinc	20	NE	5000	ND	ND	ND	ND	ND	ND
Units (mg/L) Sol. (ug/L) Water									

Legend  
 MCLs Maximum Contaminant Level  
 MDEQ Montana Department of Environmental Quality  
 NE Not Established  
 DW Dry Well  
 SS Sediment/Surface Soil  
 CS Concentration in Soil (mg/kg)  
 Concentration \* or = MCLs OR MDEQ, ARNRs, or AVE + 2 Standard Dev.  
 CRDL Confirmed Required Quantification Limit  
 RL Reporting Limit  
 ND Not Detected  
 J Compound Not Detected  
 R Results Reported on Basis of Laboratory QA/QC  
 N Presumptive Evidence of Compound

Benzene and toluene (at concentrations well below ARARs) and laboratory contaminants acetone and 2-butanone (all detections rejected) and 2-hexanone (nondetect to rejected values) were present.

The only SVOCs found were qualified low-level detections of diethylphthalate and di-n-butylphthalate. The only petroleum hydrocarbons detection was for diesel-range organics, up to a qualified maximum of 0.29 mg/L.

Eleven metals were detected in the filtered and unfiltered groundwater samples: antimony, arsenic, barium, beryllium, chromium, copper, lead, mercury, nickel, selenium, and zinc (Table 5.19). Mercury, detected at a level of 0.46  $\mu\text{g/L}$  in a dissolved sample, was above the MDEQ ARARs of 0.14  $\mu\text{g/L}$  and antimony, detected at an estimated 6  $\mu\text{g/L}$ , was equal to both the Federal and State ARARs of 6  $\mu\text{g/L}$ . Arsenic, barium, lead, and zinc, the only metals detected common to the background samples, were variously above background in the Site 8 wells.

## 6. SUMMARY OF POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The investigation is being conducted pursuant to CERCLA and in conformance with the requirements of the NCP. Section 121 of CERCLA requires remedial actions to comply with all ARARs under Federal and State environmental laws. Applicable requirements are substantive environmental protection requirements specifically addressing a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site. Relevant and appropriate requirements are those which, while not applicable, are sufficiently similar to circumstances encountered at a site that their use is well suited.

There are three types of ARARs:

- Location-specific ARARs are restrictions imposed on activities or concentrations of hazardous substances solely because they occur in special locations.
- Chemical-specific ARARs are health- or risk-based criteria that establish the acceptable amount or concentration of a chemical that may be found in or discharged to the ambient environment
- Action-specific ARARs set controls or restrictions on design and performance aspects of activities at the site.

Activities conducted during the RI/FS process must comply with ARARs to the extent practicable (40 CFR Part 300).

ARARs are progressively identified and applied on a site-specific basis as the RI/FS proceeds. The initial step in the process entails the survey of potential ARARs for the remedial action process at the subject site. The next step in the ARARs process is the comparison of statutory and regulatory requirements with site-specific factors to evaluate whether a site is currently in compliance.

Suspected sources of contamination, historical site usage, and the known or potential effects of contaminants on the environment help identify potential Federal, State, and local ARARs. The application of ARARs to the RI process is dependent on results of the field investigation. Confirmation of contamination at a site, identification of the specific contaminant(s), and subsequent laboratory analysis and quantification determine the application of chemical-specific ARARs. Additional action- and location-specific ARARs are determined when potential remediation alternatives are considered.

The degree to which site-specific factors are incorporated into the ARAR development process varies considerably. In the case of hazardous chemicals, evaluation of site-specific factors is an integral part of the ARARs process even when prerequisites based on statutory or regulatory requirements exist. Action- and location-specific ARARs are determined when any required remediation options are being considered. Groundwater ARARs are considered to be pertinent because some chemicals of potential concern in soils may impact groundwater.

The following paragraphs provide a preliminary summary of key ARARs that may be relevant to RI activities at the Base.

## 6.1 RESOURCE CONSERVATION AND RECOVERY ACT

Federal Resource Conservation and Recovery Act (RCRA) regulations governing hazardous waste management provide potential ARARs for IRP activities at the Base. RCRA regulations are applicable if waste is listed in 40 CFR 261 or is characteristic and may be relevant and appropriate if otherwise. USEPA's investigation-derived waste (IDW) policy discusses options for managing materials, such as drill cuttings and purge water, that are generated during RI activities.

**Waste Identification.** Materials excavated or removed from the site (e.g., drill cuttings, contaminated soil, and contaminated groundwater) would be regulated as hazardous waste if they meet the Federal definition provided in 40 CFR 261.

**Waste Generation and Transport.** RI activities or remedial alternatives involving the movement or removal of hazardous waste trigger RCRA hazardous waste generator requirements provided in 40 CFR 262. When hazardous waste is shipped off-site in regulated amounts, the manifesting and transport procedures in 40 CFR 263 must be followed. As applicable, the installation will sign all hazardous waste manifests as the generator of the waste.

**Land Disposal Restrictions.** RCRA regulations in 40 CFR 268 set forth Land Disposal Restrictions for RCRA wastes. These restrictions were required by the Hazardous and Solid Waste Amendments (HSWA) of 1984 to prohibit the continued land disposal of hazardous wastes beyond specified dates. However, wastes treated in accordance with chemical-specific treatment standards provided in 40 CFR 268 Subpart D may be land-disposed as provided therein. The Land Disposal Restrictions potentially affect the disposal of hazardous wastes generated during RI or subsequent remedial activities and may be considered both action- and chemical-specific ARARs.

**Treatment, Storage, and Disposal Facilities.** If remedial alternatives for the site involve the construction or off-site use of RCRA treatment, storage, and disposal (TSD) facilities, regulations provided in 40 CFR 264 become action-specific ARARs. Various subsections of 40 CFR 264 govern standards and procedures for the operation of hazardous waste TSD facilities. For example, a common disposal practice is to create a waste pile of contaminated soil as part of the remediation process. 40 CFR 264 Subpart L promulgates Federal RCRA standards for waste piles, including their design, operating requirements, monitoring and inspection, closure, and postclosure care. Other subparts control tank systems, surface impoundments, land treatment units, landfills, incinerators, and miscellaneous TSD units.

## 6.2 SAFE DRINKING WATER ACT

Federal regulations promulgated pursuant to the Safe Drinking Water Act (SDWA) govern the quality, usage, and discharge of groundwater. MCLs specified in 40 CFR 141.11–141.16 are legally enforceable Federal drinking water standards established by USEPA. Maximum contaminant level goals (MCLGs) specified in 40 CFR 141.50–141.51 are nonenforceable, health-based goals for drinking water. MCLGs are set at levels at which no adverse health effects may arise. MCLs are set as close as practical to MCLGs. The Primary Federal Drinking Water Standards and Montana Numeric Water Quality Standards for VOCs and SVOCs are presented in

Tables 6.1, 6.2, and 6.3. A more complete compilation of both Federal and State water quality standards is provided in Appendix L. Human Health Standards (HHSs) are enforced in Montana by the Montana Department of Health and Environmental Services (MDHES). As specified by the USEPA, State HHSs must be no less stringent than ones established by the USEPA. The State of Montana enforces their HHS or USEPA MCLs, dependent upon which is the most stringent. These potential ARARs may be used to identify a range of target clean-up levels for groundwater at the installation.

### **6.3 CLEAN WATER ACT**

The Federal Clean Water Act (CWA) and pursuant regulations provide potential location-, chemical-, and action-specific ARARs for IRP activities at the installation. Because no wetlands or surface water bodies are located either on-site or downgradient of the sites, Federal, State, and/or local surface water, wetlands, or sediment ARARs do not apply.

**Ambient Water Quality Criteria.** The USEPA has promulgated Ambient Water Quality Criteria (AWQC) for surface and groundwater through 40 CFR 131. Candidate remedial actions involving contaminated surface water or groundwater must be evaluated within the context of follow-on water usage and the circumstances or the actual or potential release before implementation. As a general statement, AWQC are applied when evaluating cleanup levels.

**National Pollutant Discharge Elimination System.** The 120th FW is a co-permittee in a National Pollutant Discharge Elimination System (NPDES) permit with the City of Great Falls. Permit requirements and conditions provide action- and chemical-specific ARARs.

### **6.4 OCCUPATIONAL SAFETY AND HEALTH ACT**

As required by the NCP, all site operations are governed by Occupational Safety and Health Act (OSHA) standards of health and safety under 29 CFR 1910.120 (40 CFR 300.150). The health and safety officer for the RI field investigation will ensure all site workers meet the requirements of the Health and Safety Plan, possess and use all PPE, and take all precautions to eliminate exposure to unsafe or unhealthy situations. Other applicable OSHA requirements include health and safety for construction (29 CFR 1926), general industry (29 CFR 1910), and recordkeeping and reporting (29 CFR 1904).

### **6.5 HAZARDOUS MATERIALS TRANSPORTATION ACT**

If material containing hazardous wastes is to be transported off-site, U.S. Department of Transportation (DOT) hazardous material transportation requirement in 49 CFR 171-179, pursuant to the Federal Hazardous Materials Transportation Act (HMTA), may be action-specific ARARs for RI activities. These requirements are supplemental to RCRA transporter requirements in 40 CFR 263. Stored hazardous materials should be containerized and labeled in accordance with requirements.

Table 6.1  
Volatile Organic Compounds  
Primary Federal Drinking Water Standards and Montana Numeric Water Quality Standards  
120th FW, Montana Air National Guard, Great Falls, Montana

Parameter	CAS Number <sup>b</sup>	USEPA Method <sup>a</sup> Detection Limit (µg/L)	USEPA MCLs (µg/L)	USEPA PMCLs (µg/L)	MDHES HHSs (µg/L)	MDHES RRVs (µg/L)
Acetone	67-64-1	NE	NE	NE	NE	NE
2-Butanone	78-93-3	NE	NE	NE	NE	NE
1,1-Dichloroethene	75-35-4	0.2	7.0	NE	0.57	0.8
1,2-Dichloroethene	107-06-2	0.2	70	NE	5.7	0.5
1,1,1-Trichloroethane	71-55-6	0.2	200	NE	200	0.5
Trichloroethene (TCE)	79-01-6	0.2	5.0	NE	5	0.5
Chloroform	67-66-3	0.2	100	NE	57	0.5
Trans-1,2-Dichloroethene	156-60-5	0.2	100	NE	100	0.5
1,4-Dichlorobenzene	541-73-1	0.2	75	NE	75	10.0
1,2-Dichlorobenzene	95-50-1	0.2	600	NE	600	10.0
1,1-Dichloroethane	75-34-3	0.2	NE	NE	NE	0.5
Tetrachloroethene	127-18-4	0.2	5.0	0.2	0.8	0.5
Chlorobenzene	108-90-7	0.5	100	NE	20	0.5
Benzene	71-43-2	0.5	5.0	NE	5	0.5
Ethylbenzene	100-41-4	0.5	700	NE	700	0.5
Toluene	108-88-3	0.5	1000	NE	1,000	0.5
Xylenes	1330-20-7	0.5	10000	NE	10,000	1.5

<sup>a</sup> USEPA Method 502.2

<sup>b</sup> Chemical Abstract Service Number

USEPA = United States Environmental Protection Agency

µg/L = micrograms per liter

MCL = Maximum Contaminant Level

PMCL = Proposed Maximum Contaminant Level

MDHES = Montana Department of Health and Environmental Services

NE = Not Established because of insufficient data

HHS = Human Health Standards

RRV = Required Reporting Value

Table 6.2  
Semivolatile Organic Compounds  
Primary Federal Drinking Water Standards and Montana Numeric Water Quality Standards  
120th FW, Montana Air National Guard, Great Falls, Montana

Parameter	CAS Number <sup>a</sup>	Method Detection Limit (µg/L)	USEPA MCLs (µg/L)	USEPA PMCLs (µg/L)	MDHES HHs (µg/L)	MDHES RRVs (µg/L)
1,2-Dichlorobenzene	95-50-1	1.9	600	NE	600	10.0
Naphthalene	91-20-3	1.6	NE	NE	NE	10.0
2-Methylnaphthalene	91-57-6	NE	NE	NE	NE	NE
Bis(2-ethylhexyl)phthalate	117-81-7	2.5	6	4.0	6	10.0
Di-n-butylphthalate	84-74-2	NE	NE	NE	2700	0.25
Diethyl phthalate	84-66-2	1.9	NE	NE	23,000	0.25
Phenanthrene	85-01-8	5.4	NE	NE	NE	0.25
Fluoranthene	206-44-0	2.2	NE	NE	300	10.0
2,4-Dimethylphenol	105-67-9				400	10.0
Pyrene	129-00-0	1.9	NE	NE	9,600	0.25

<sup>a</sup> Chemical Abstract Service Number  
 µg/L = micrograms per liter  
 MCL = Maximum Contaminant Level  
 PMCL = Proposed Maximum Contaminant Level  
 MDHES = Montana Department of Health and Environmental Services  
 NE = Not Established because of insufficient data  
 HHs = Human Health Standards  
 RRV = Required Reporting Value



**Table 6.3**  
**Inorganic Compounds Primary Federal**  
**Drinking Water Standards**  
**120th FW, Montana Air National Guard,**  
**Great Falls, Montana**

Metal	MCL ( $\mu\text{g/L}$ )	HHS ( $\mu\text{g/L}$ )
Antimony	6	6
Arsenic	50	18
Barium	2,000	1,000
Beryllium	4	40
Cadmium	5	5
Chromium	100	100
Copper	1,300	1,000
Lead	15	15
Mercury	2	0.14
Nickel	100	100
Selenium	50	50
Silver	NE	NE
Thallium	2	1.7
Zinc	NE	5,000

NE = ARARs not established.

## 6.6 CLEAN AIR ACT

The Federal Clean Air Act (CAA) may provide action- and chemical-specific ARARs for IRP activities, including field investigations and subsequent remedial actions, including soil excavation or incineration. All remediation activities must comply with National Primary and Secondary Ambient Air Quality Standards (NAAQS) found in 40 CFR 50. Rules governing particulate matter less than 10 microns in size ( $PM_{10}$ ), which can have potential detrimental effects on the lungs, are contained in 40 CFR 50. All field activities involving air emissions must ensure compliance with the  $PM_{10}$  standard.

## 6.7 FEDERAL GUIDANCE TO BE CONSIDERED

In addition to Federal and State requirements that may be applicable or relevant and appropriate to IRP activities, Federal nonregulatory criteria should be considered. These chemical-specific to be considered, used to help characterizing risks and to set cleanup goals, include the following:

- U.S. EPA Risk Reference Doses;
- U.S. EPA Health Advisories;
- U.S. EPA Carcinogen Assessment Group Potency Factors;
- U.S. EPA Acceptable Intake Values, Chronic and Subchronic; and
- U.S. EPA guidance manual on water-related fate of 129 priority pollutants.

## 6.8 STATE REQUIREMENTS

In addition to Federal ARARs, several State of Montana regulations may be applicable or relevant and appropriate to RI activities and potential remedial alternatives at the Montana ANGB.

**Montana Hazardous Waste and Underground Storage Act.** The Montana Department of Environmental Quality (DEQ), formerly MDHES, regulates underground storage tanks (USTs) and imposes requirements for release-detection notification and reporting, corrective actions, closures, and other subjects. If during the course of the investigation a UST is found to be leaking, these ARARs will become action-specific standards. (DEQ 1996)

**Montana Comprehensive Environmental Cleanup and Responsibility Act.** The Montana DEQ regulates State superfund sites under CERCLA, a regulatory program that parallels the Federal CERCLA program. Comprehensive Environmental Cleanup and Responsibility Act may provide relevant and appropriate requirements for RI and remedial activities at the 120th FW site.

**Montana Hazardous Waste Management Regulations.** Rules and criteria for the identification, storage, treatment, transportation, and disposal of hazardous wastes are established in these regulations. These regulations provide potential ARARs for RI activities involving the movement or removal of hazardous wastes.

**Montana Numeric Water Quality Standards.** Standards have been written to supplement Federal water quality requirements and may be considered potential action- or chemical-specific ARARs for the RI or planned remedial actions. The Montana DEQ regulates all public water supplies in the State and has established MCLs that may be used as cleanup levels for remedial activities. A complete list of Montana Numeric Water Quality Standards (DEQ 1995) is provided in Appendix L.

**Montana Remedial Action Regulations for Hazardous Substance Spills.** The Montana DEQ uses these regulations as baseline guidance when considering candidate remedial activities and in analyzing contaminants among sites requiring remedial action. These regulations provide potential ARARs for RI activities and subsequent remedial actions.

## **6.9 LOCATION-SPECIFIC ARARS**

There are no wetlands or surface water bodies either on-site or downgradient of the sites. As stated previously, however, new information discovered during the field investigation and subsequent laboratory analyses may broaden the initial set of project ARARs.

## 7. CONTAMINANT FATE AND TRANSPORT

The distribution and extent of contamination is based on the physical characteristics of differing chemical or contaminant groups and the physicochemical properties of environmental media at the site. Organic chemicals and inorganic elements have different physical properties that govern their behavior in the environment.

Contaminant fate and transport is defined by a chemical's ability to move through media, the ease with which it can transfer from one medium to another, and transform or degrade. The major processes at work in the natural environment include volatilization, solubilization, sorption, oxidation/reduction, and biodegradation. The fate of contaminants in the environment is controlled by the characteristics of the constituents (e.g., solubility and volatility) and the environmental medium (e.g., organic carbon content and porosity of the soil and pH of groundwater). For the purposes of this RI report, only a qualitative evaluation of potential routes of migration, contaminates of persistence, and contaminant migration are presented. Fate and transport modeling was not included in the scope of work for the RI.

### 7.1 POTENTIAL ROUTES OF MIGRATION

Several potential routes of migration exist at the Base by which chemicals may migrate from source locations. Contaminated soil, sediment, surface water, and groundwater all may act as sources of contaminants. The potential routes of migration considered here are:

- Migration into surface water from precipitation runoff.
- Migration of contaminants into the air via fugitive dust emissions and volatilization.
- Migration into groundwater by percolation of rainfall with subsequent leaching and transport.

There is no permanent surface water body located within the Base boundary at Great Falls. Site 6, however, contains a drainage ditch that collects water in times of heavy precipitation. This drainage ditch empties on the Base into a buried storm drain system. Sediment is contained in the shallow ditch and may act as a source during rainfall. Most of the surface area of the three sites are beneath asphalt, and the erosion and transport of contaminated sediment by overland runoff is not likely.

Site-related compounds may be released through volatilization into the air; this migration pathway is limited primarily to volatile compounds in surface soils. All of the source areas of contamination, except for the grassy area in front of Building 23/24 and the sediment in the drainage ditch at Site 6, are located beneath asphalt areas. Significant migration routes via air emissions is considered unlikely.

Migration of soil contamination via percolation of rainfall and subsequent entry of the leachate into groundwater is considered as the most probable route of contaminant migration. Several unknowns to this scenario, however, include the effectiveness of infiltration and percolation of precipitation on contaminant migration in view of the large areas of the facility covered by buildings and asphalt, the effect of the distance from the weathered soil profile though bedrock to the groundwater, and the presence of fractures in the bedrock.

## 7.2 CONTAMINANT PERSISTENCE

### 7.2.1 Organic Compounds

Five primary groups of organic constituents have been detected at the Base. These include ketones, aromatic hydrocarbons, chlorinated hydrocarbons, SVOCs, and petroleum hydrocarbons. The constituents have been detected at varied concentrations in both soil and groundwater at Sites 6, 7, and 8. The following sections describe general behavior characteristics of these constituents in the soils and aquifer matrix at the Base. Additional information regarding soil and aquifer physical and chemical properties may be found in Sect. 5 of this report.

Ketones Ketones detected at the Base primarily consist of acetone, 2-butanone, and 2-hexanone. These compounds are highly soluble in water and tend to have moderate to low retardation or affinity for soils. Detections of these compounds have been found in surface and subsurface soils at the three sites; however, the concentrations have generally been low. Based upon the solubility and other chemical properties, ketones tend to be mobile in groundwater; however, these low soil detections have not been matched by similar detections in groundwater. Typical release of these constituents appears to be as minor constituents mixed with other chemicals. No large quantity usage of the detected ketones has been noted. Significant releases of ketones has not been observed.

Aromatic Hydrocarbons Aromatic hydrocarbons are a primary component of fuel. Typical compounds are benzene, ethylbenzene, toluene, and xylene. These constituents have been detected at the sites. The aromatic VOCs detected in soils are volatile, soluble, and biodegradable. They are not likely to be persistent in the soils and may be mobilized to groundwater by infiltration and recharge. Aromatics have moderate solubility in water and tend to be fairly mobile as noted in the minor occurrence of these compounds in groundwater at these sites. In sufficient concentrations, aromatic hydrocarbons may form floating nonaqueous phase liquids because their specific gravity is less than that of water. Free product was found at Site 7 in monitoring well 7MW-1.

The constituents are easily aerobically biodegraded in both soil and groundwater. Recent work by numerous authors has demonstrated that indigenous microbes are ubiquitous and adapt readily to the introduction and presence of aromatic hydrocarbons. Viability of the microbial community is dependent upon nutrient, oxygen, and moisture available to them. Active biologic processes are often indicated by reduced dissolved oxygen and localized reducing conditions within the body of a plume. Aerobic biodegradation is often spurred by the presence of ideal conditions at the margin or leading edge of a plume and has been noted as occurring relatively rapidly. The extent of aromatic hydrocarbons in the groundwater was defined during this investigation and does not represent significant lateral dispersion, thus indicating that biodegradation may be occurring at a rate comparable to that of groundwater movement across the site.

Chlorinated Hydrocarbons Chlorinated hydrocarbons tend to have high solubility in water and specific gravity is generally higher than that of water. The constituents tend to have a low affinity or retardation in soils and are generally highly mobile through the soil column and in most aquifers. The contaminant suites detected at the sites indicate that anaerobic or methanotropic degradation may be occurring in the groundwater at Site 8. Numerous chlorinated compounds

indicative of degradation were found; these include, in part, cis-1,2-dichloroethene, 1,1-dichloroethane, 1,1-dichloroethene, and vinyl chloride.

**SVOCs** SVOCs detected in soil and water at the Base consisted of fuel-related naphthalenes, PAHs, and phthalate esters. The semivolatiles have higher molecular weights than the volatile compounds. They also have lower vapor pressures, lower solubilities, and higher organic carbon partition coefficients ( $K_{oc}$ ). These compounds are expected to be strongly adsorbed by site soils and therefore less mobile in the environment. PAHs tend to have a high affinity for soils and as such exhibit low mobility characteristics. Typically the naphthene, fluoranthene, pyrene, and anthracene compounds are persistent in the soil media into which they are released; however, they are not mobile and lack the chemical and physical properties to effect cross-media contamination.

**Petroleum Hydrocarbons** The fate of petroleum hydrocarbons in soils is affected primarily by their distribution, volatility, and leaching potential. The low-molecular-weight aromatic hydrocarbons partially evaporate; the remaining heavier molecular weight hydrocarbons will migrate to different depths in the soil column and possibly to groundwater. The proportion of petroleum hydrocarbons that will adsorb to soil particles rather than continue migration depends on the type of soil, the particular petroleum product involved, the volume of release, and the amount of infiltration and percolation of rainfall. In general, leaching to the groundwater is favored by high infiltration and permeable soils. Because the sites are mainly capped by asphalt surfaces, even high rainfall will not cause movement.

### 7.2.2 Inorganic Compounds

Metals occur naturally in the environment, principally as cations within the crystal lattice structure of minerals. Unlike the organic compounds discussed above, metals are not degradable through biological or chemical actions and can be considered infinitely persistent in the environment. However, metals can be oxidized or reduced through the actions of microorganisms that can change their chemical and physical properties.

The mobility of metals in the environment is generally low, with sorption being the most important in controlling their migration. Most of the metals detected at the Base have a high potential for sorption in the soil and therefore have low mobilities. Exceptions are arsenic in the highly soluble oxyanion form and nickel, which has the highest mobility of all the heavy metals listed. Environmental factors that influence the mobility of metals include soil type (metals are readily sorbed by clay minerals and organic matter), pH (metals are more soluble at low pHs), biomethylation, and chemical oxidation and reduction.

## 7.3 CONTAMINANT MIGRATION

Potential contaminant migration pathways identified include volatilization of VOCs from surface soil and sediment to the atmosphere (possible at the Site 6 drainage ditch and Site 7 from soils in the grassy area of the presumed dry well location), leaching of contaminants within subsurface soils to the underlying bedrock sandstones and to the groundwater, and transport of contaminants within the groundwater flow system of the aquifer. However, based on the soil and groundwater data collected at the sites, the most significant contaminant migration pathway is the

leaching of contaminants within subsurface soils through bedrock and to the groundwater and the transport of contaminants within the groundwater flow system.

The leaching of contaminants from the subsurface soils to the groundwater system occurs as infiltrating precipitation, which percolates through contaminated soil in the unsaturated zone and partitions contaminants from the soil matrix into the leachate. The leachate may percolate through the bedrock and eventually reach the water table and mix with groundwater beneath and somewhat downgradient from the source area. Groundwater may then move the dissolved contaminants away from the source area as an advective plume that is subject to dilution and dispersion effects.

Vertical transport modeling was not performed for the sites. Significant leaching of organic contaminant from the soil at the three sites is considered unlikely. Except for a small area of Site 7, all the sites are effectively capped by asphalt and buildings. Organic contaminants in the soil are VOCs (which, although relatively mobile, occur at relatively low concentrations) and SVOCs and PAHS (which, although some occur at moderate concentrations, are relatively immobile because of their propensity to bind to soils). However, it is considered that leaching from near-surface soil sources could be an important pathway for those contaminants that remain at high concentrations and that have a very low soil-water partition coefficient and are, consequently, very mobile in the soil-water system.

Potentiometric maps prepared from the SI data and water level elevation data from the RI consistently show a northwest to west-northwest groundwater flow direction. The data taken during the RI are shown on Figs. 5.4, 5.5, and 5.6. Two partial groundwater divides are interpreted as existing to the west of Site 6 and 8; the axis divides trend to the north. Although these fluctuations in flow direction are present, the overall groundwater flow direction is considered to be to the northwest.

Groundwater contamination in the bedrock aquifer will be transported horizontally in the direction of groundwater flow. Although record searches of the available data indicated there are active residential wells within a mile of the Base, none are located downgradient of the sites in question. Calculated linear velocities for groundwater, depending upon the steepness of the horizontal hydraulic gradient, may range from around 2.43 ft/day to as much as 5.58 ft/day. These values were derived in Sect. 5.1.2.3, where they were considered as high-side values. Accepting these values, over a 10-year period groundwater may move as much as 8,870 ft to 20,370 ft. The contaminant transport velocity,  $V_c = (V_p)/R$ , can be expected to move at a slower rate than the estimated velocity of the groundwater. In the equation,  $V_p$  is the groundwater velocity of the pore-water and  $R$  is the retardation factor. Typical  $R$  values range from 3 for very mobile compounds such as vinyl chloride to about 50 for less mobile compounds such as naphthalene. Because no evidence exists that contaminants have moved anywhere close to these distances (based on the analytical data from downgradient wells), it may be concluded that either degradation processes remove contaminants from the groundwater or, as discussed in Sect. 5.1.2.3, the slug test data are not truly representative of site conditions.

## 8. PRELIMINARY RISK EVALUATION

### 8.1 INTRODUCTION

A PRE is a screening-level risk assessment intended to identify contaminants in each affected medium that could be associated with potential adverse effects to exposed human or ecological receptors. The results of the PRE are used to determine which sites, if any, should be investigated further or require no further action. In general, conservative (health protective) assumptions are used throughout a screening risk assessment that do not consider site-specific information in detail. This type of evaluation is particularly useful in establishing those sites that require no further action based on worst case assumptions. The PRE is not the equivalent of a baseline risk assessment (BRA). The level of effort for the PRE differs from the BRA. A BRA is intended to fully characterize and quantify, on a site-specific basis with site-specific parameters, all exposures to all likely receptors across all media. The PRE is limited to a screening-level risk assessment with limited quantification and modeling based on available data.

#### 8.1.1 Site-Specific Objectives of the Preliminary Risk Assessment

The objective of the PRE is to provide data in sufficient quantity and quality to proceed to a decision point with respect to further investigation or remediation of the site if either of these is warranted. The PRE will be used to support recommendations for one of the following alternatives:

- Decision Document (DD) (no further action),
- Study (FFS)/Remedial Measure (RM)

The methodology employed for the risk evaluation phase of the project is based on principles contained in the *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Parts A and B* (USEPA 1989a and 1991a); *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Part A, Supplemental Guidance, Standard Default Exposure Factors* (USEPA 1991b); and *Data Useability in Risk Assessment* (USEPA 1992a). Because USEPA Region VIII has used USEPA Region III and Region IX methods in the past for site screening and risk-based concentration development, this PRE will use the most recent version of the USEPA Region III and Region IX methods for applying risk-based concentrations (RBCs) and preliminary remediation goals (PRGs) for site screening (USEPA 1996a and b). An overview of the PRE procedures is given in the following sections.

#### 8.1.2 Organization of the Preliminary Risk Evaluation Sections

This PRE consists of a human health evaluation only. Because the sites are mostly paved and within an industrial area, it was determined there would be no ecological receptors impacted by contaminants of potential concern; therefore, no ecological evaluations were conducted. The methodology used in the human health, as well as facility information applicable to all sites evaluated in the RI, is described in Sect. 8.2. Section 8.2.2 discusses the chemical and physical properties of the contaminants of potential concern. Section 8.4 provides the results of the PREs for each of the sites in the RI. Section 8.5 provides summaries and conclusions for the sites.



## **8.2 HUMAN HEALTH PRELIMINARY RISK EVALUATION APPROACH**

The following sections present the approach to evaluating human health risks. These sections also provide general information applicable for all sites.

### **8.2.1 Identification of Chemicals of Potential Concern**

The initial step in conducting a risk evaluation is the identification of existing chemical concentrations that may be of concern. The purpose of this selection process is threefold. First, the acceptability of analytical data for the risk evaluation is determined. Second, site-related contaminant concentrations are distinguished from background levels. In the final step, essential macronutrients unlikely to contribute significantly to risk are eliminated. Separate contaminants of potential concern (COPCs) were selected for the different environmental media at each of the sites. A discussion of the selection process is given below.

A complete summary of field activities and associated data can be found in earlier sections of this report. Soil samples were taken and sent off-site for evaluation. Samples were analyzed for VOCs, SVOCs, TPH, and inorganics based on site history and previous sampling efforts. All laboratory samples have been through data validation resulting in HAZWRAP Level C data.

Chemicals detected in each medium were evaluated using the criteria described below.

#### **8.2.1.1 Blank Contamination**

Because of the presence of several laboratory contaminants in virtually all environmental sampling efforts, USEPA has developed guidance for eliminating these contaminants from consideration as COPCs. As part of the data validation process, a chemical was not considered further if the maximum sample concentration did not exceed 10 times the highest blank concentration for all common laboratory contaminants (2-butanone, acetone, methylene chloride, toluene, and phthalates) or five times the highest blank for other chemicals (USEPA 1989a). These criteria were developed by the USEPA to prevent the inclusion of chemicals that are most likely sampling or analytical artifacts.

#### **8.2.1.2 Background Concentrations in Reference Soils**

As discussed in Sect. 5.2, the background samples collected during the SI indicated ranges for inorganics that were consistently and significantly lower than the regional range. Therefore, in an effort to accurately characterize natural background concentrations for inorganics analytes, RI sampling results for inorganic analytes were compared to both ranges. Only those analytes exceeding both ranges were considered site-related contaminants. Background concentrations of chemicals can be naturally occurring or anthropogenic.

#### **8.2.1.3 Essential Nutrients**

Calcium, magnesium, potassium, and sodium are essential macronutrients, are generally toxic only at very high doses, and are ubiquitous in the environment. Consequently, these constituents are eliminated from the list of COPCs.

## 8.2.2 Chemical and Physical Properties of Contaminants of Potential Concern

In this section the physical and chemical properties of the COPCs are presented and the relevance of these properties to environmental fate and transport is discussed. Physical and chemical properties of the COPCs will affect the extent to which they might migrate through the environment.

The water solubility of a substance is a critical property affecting environmental fate. Highly soluble chemicals can be rapidly leached from wastes and soils and are generally mobile in groundwater. Solubilities can range from less than 1 milligram per liter (mg/L) to totally miscible; most common organic chemicals fall between 1 mg/L and 1,000,000 mg/L. The solubility of chemicals that are not readily soluble in water may become enhanced in the presence of organic solvents that themselves are more soluble in water.

Volatization of a compound will depend on its vapor pressure, water solubility, and air diffusion coefficient. Highly water-soluble compounds generally have lower volatilization rates from water unless they also have high vapor pressures. Vapor pressure, a relative measure of the volatility of chemicals in their pure state, ranges from roughly 0.001 to 760 millimeters of mercury (mmHg) for liquids. The Henry's Law Constant, which combines vapor pressure with solubility, is more appropriate than vapor pressure alone for estimating releases from water to air for compounds having Henry's Law Constants. Compounds with Henry's Law Constant greater than  $10^{-3}$  atmospheres cubic meters per mole ( $\text{Atm}\cdot\text{m}^3/\text{mole}$ ) can be expected to readily volatilize from water. Those with values ranging from  $10^{-3}$  to  $10^{-5}$   $\text{Atm}\cdot\text{m}^3/\text{mole}$  are associated with possibly significant, but not facile, volatilization; compounds with values less than  $10^{-5}$   $\text{Atm}\cdot\text{m}^3/\text{mole}$  will only volatilize from water to a limited extent.

The organic carbon partition coefficient ( $K_{oc}$ ) reflects the propensity of a compound to sorb to organic matter in soil. The normal range of  $K_{oc}$  values is 1 to  $10^7$  milliliters per g (mL/g); higher values indicate greater sorption potential. Chemicals that have a strong tendency to sorb to organic matter will move more slowly in the subsurface environment than chemicals with low  $K_{oc}$ s.

COPCs were classified into several categories according to their similarity in chemical structure and/or physicochemical properties (factors that influence mobility in the environment). The chemical categories are:

- inorganic,
- volatile organic compounds,
- semivolatile organic compounds,
- PAHs (polyaromatic hydrocarbons), and
- other TPH.

## 8.2.3 Exposure Evaluation

This section presents the evaluation of the potential exposure of humans to chemicals found at hazardous waste sites. The exposure evaluation determines what receptor populations are present, the exposure pathways that exist for these populations, and which exposure scenario

represents a worst-case exposure. The general procedure for conducting an exposure assessment involves the following steps:

- characterizing the exposure setting,
- identifying exposure pathways, and
- quantifying exposure.

Each of these sections is discussed below in the context of a PRE.

#### **8.2.2.1 Characterization of Exposure Setting**

Characterization of the exposure setting involves characterizing the physical and demographic characteristics of the site. Information regarding the physical and chemical characteristics of contaminants and the information regarding the migration of contaminants obtained during the site characterization studies enables the risk assessor to identify exposure points and exposure routes as well as potential receptors. The location of current populations relative to the site are identified, and current and future land uses are determined. The site description includes the relationship of the site to other major features of the environment.

##### **Current land use and potentially exposed populations**

The current land use of each site is used to determine potentially exposed populations that should be considered when quantifying exposure or determining the scenarios to be used when selecting risk-based criteria. Because many of the sites at the Base are similar in their current use, general information is provided here in the methodology section; more substantial site-specific information will be provided in the exposure evaluations for each site in Sect. 8.4.

The Base is located on the south side of the Great Falls International Airport in Great Falls, Montana. The airport is located west of the city and situated between the Sun River to the north and the Missouri River to the south. The Base is approximately 2 miles northeast of the confluence of these two rivers. The current Base boundary occupies approximately 125 acres, which is leased from the airport authority. Open range and agricultural land border the airport to the north and west.

All sites considered in the RI are located within the fenced boundary of the Base. All of these sites are also within a highly industrialized area consisting of paved areas and buildings with extremely limited vegetative cover. None of the sites would support a viable ecological habitat, thus greatly limiting the potential for an ecological receptor to be impacted by contaminants of potential concern. Therefore, no ecological risk evaluation was conducted for any of the sites.

The Base lies on the northeastern edge of the Sun River bench, a topographic feature situated about 350 ft above the Sun and Missouri confluence about 2 miles northeast of the Base. The Base obtains potable water from the City of Great Falls. The City of Great Falls water supply is obtained from the Missouri River. The storm runoff drains into the Sun River via a network of swales, ditches, culverts, drop inlets, collector pipes, and truck lines. Other Base runoff flows into the sanitary sewers and eventually reaches the city's waste treatment facility, which discharges to the Missouri River. There are no known supplemental groundwater supply wells located on-site.

Regional groundwater flow is to the west-northwest. The Flood Sandstone on the Sun River bench is a perched aquifer (HAZWRAP 1992). Wells completed in the Flood are less than 100 ft deep and are important sources of water for domestic and stock uses on the bench. Although record searches indicated there are active residential wells within a mile of the base, none are located downgradient of the sites in question. Therefore, the future scenario for residential groundwater use was not evaluated based on the current understanding of site conditions.

#### **Future land use**

There are four broad categories of land use: residential, agricultural, industrial, and recreational. Placing land use in one or more of these categories defines the exposure points, receptors, and exposure routes that are likely to be significant and provides the basis for choosing exposure factors. As stated previously, most of the sites considered in this RI are highly industrialized and will remain under industrial use for the foreseeable future. Land use designations are also used in determining the risk scenarios to be evaluated in the PREs and whether an ecological PRE is warranted. USEPA Region III and Region IX have default exposure factors for both soil and water exposure routes that are routinely considered in screening level risk evaluations for various land uses.

#### **8.2.2.2 Identification of Exposure Pathways**

The following elements must be present for a complete exposure pathway to exist:

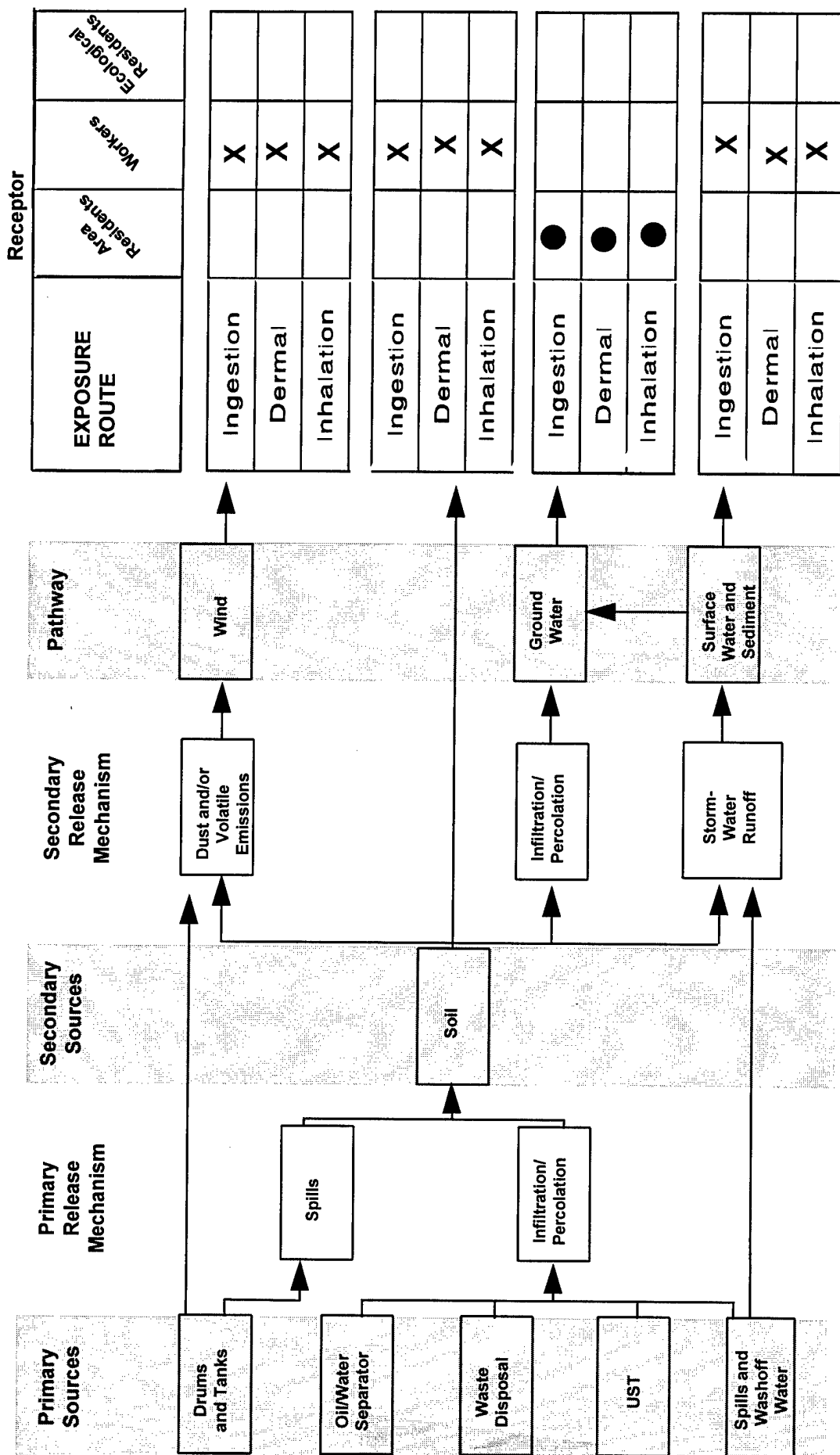
- a source or mechanism of chemical release,
- a transport or retention medium,
- a point of potential contact with the chemical,
- a route of exposure at the point of contact, and
- a receptor.

The exposure pathways analysis evaluates these components to establish the likelihood of exposure for each medium at the sites. For the purposes of the PREs, a general discussion of each potential exposure pathway, and whether each pathway is considered in the development of the analyte specific Region III RBCs and the Region IX PRGs used in the risk evaluation, is given below. The site-specific evaluation for each of the sites is given in Sect. 8.4. The general conceptual site model is shown in Fig. 8-1.

#### **Air pathways**

Site-related compounds in soils may be released through volatilization. This could result in potential exposures to on-site industrial workers through inhalation. This migration pathway is limited primarily to volatile compounds in surface soils. However, chemicals may be released from subsurface soils into the air as a result of excavation.

Figure 8.1 Conceptual Site Model



Legend

- Potential pathways not evaluated.
- X Potentially completed pathways evaluated.

Particulate-bound chemicals also may be transported through wind erosion or generation of fugitive dust. This pathway is limited to compounds found in the surface soils or chemicals released during excavation or similar industrial activities.

Air data are not available for any of the sites, and the procedures used to evaluate soil exposure in the USEPA Region III RBCs do not include exposure to contaminants that have migrated into the air. However, Region IX does include exposure to contaminants that have migrated into the air; for this reason air pathways are evaluated in the PRE.

### **Soil pathways**

All the sites with contaminants in the soils are intended for industrial use for the foreseeable future. Workers could be exposed through inhalation, ingestion, or dermal contact with surface soils, and they could be exposed to subsurface soils in the same manner if excavation were to occur. Although only ingestion of soils is considered in the Region III RBCs, Region IX PRGs evaluation does include both inhalation and dermal absorption routes of exposure.

### **Surface water pathways**

No surface water pathways were considered during this investigation.

### **Sediment pathways**

Sediment exposures are expected to be extremely limited because Site 6, the only site with sediment data, is within the fenced boundary of the facility and is not used for any particular activities on-site. However, to provide information regarding the level of contamination present in the sediment, sediment concentrations will be screened against the industrial soil RBCs and PRGs as a conservative measure of the potential for risk in the absence of sediment screening values in the Region III and Region IX documents.

### **Groundwater pathways**

Exposure to groundwater could occur if the groundwater contamination migrates to a point of exposure, such as a public or private well. Although record searches indicated there are active residential wells within a mile of the base, none are located downgradient of the sites in question. Therefore, the future scenario for residential groundwater use was not evaluated based on the current understanding of site conditions.

#### **8.2.2.3 Quantification of Exposure**

Based on the evaluation of potential exposure scenarios at Great Falls ANGB, it was determined that the risk-based screening criteria provided by Region III and Region IX are adequate for the evaluation of risk at the sites in the RI. The potential soil exposure pathways identified involve standard exposures of an industrial nature. Sediments were evaluated as soils in terms of exposure. This approach was taken because risk-based screening criteria for sediment are not included in the Region III and Region IX documentation and evaluating these media in this manner ensures a conservative (i.e., more protective) approach. Tables 8.1 and 8.2 provide all the exposure parameters used for the derivation of the RBCs and PRGs, respectively.

Figures 8.2 and 8.3 show the equations used to derive the RBCs and PRGs, respectively. Note the equations include toxicity values are explained in Sect. 8.2.3.

**Table 8.1. Exposure Parameters for RBC Derivation**

Exposure variables	Value	Symbol
<i>General</i>		
Carcinogenic potency slope factor oral (risk per mg/kg/d)	*	CPSo
Carcinogenic potency slope factor inhaled (risk per mg/kg/d)	*	CPSi
Reference dose oral (mg/kg/d)	*	RfDo
Reference dose inhaled (mg/kg/d)	*	RfDi
Target cancer risk	1e-06	TR
Target hazard quotient	1	THQ
Body weight, adult (kg)	70	BWa
Averaging time carcinogens (d)	25550	ATc
Averaging time noncarcinogens (d)	ED*365	ATn
Inhalation, adult (m <sup>3</sup> /d)	20	IRAA
Soil ingestion, adult (mg/d)	100	IRSa
<i>Occupational</i>		
Exposure frequency (d/y)	250	EFo
Exposure duration (y)	25	EDo
Fraction of contaminated soil ingested (unitless)	0.5	FC

**Table 8.2 Standard Default Factors**

Symbol	Definition (units)	Default	Reference
CSFo	Cancer slope factor oral (mg/kg-d)-1	--	IRIS, HEAST, or NCEA
CSFi	Cancer slope factor inhaled (mg/kg-d)-1	--	IRIS, HEAST, or NCEA
RfDo	Reference dose oral (mg/kg-d)	--	IRIS, HEAST, or NCEA
RfDi	Reference dose inhaled (mg/kg-d)	--	IRIS, HEAST, or NCEA
TR	Target cancer risk	10 <sup>-6</sup>	--
THQ	Target hazard quotient	1	--
BWa	Body weight, adult (kg)	70	RAGS (Part A), EPA 1989 (EPA/540/1-89/002)
ATc	Averaging time - carcinogens (days)	25550	RAGS(Part A), EPA 1989 (EPA/540/1-89/002)
ATn	Averaging time - noncarcinogens (days)	ED*365	
SAa	25% Surface area, adult (cm <sup>2</sup> /day)	5000	Dermal Assessment, EPA 1992 (EPA/600/8-91/011B)
AF	Adherence factor (mg/cm <sup>2</sup> )	0.2	Dermal Assessment, EPA 1992 (EPA/ 600/8-9/011B)
ABS	Skin absorption (unitless)		
	-- organics	0.1	PEA, Cal-EPA (DTSC, 1994)
	--Inorganics	0.01	PEA, Cal-EPA (DTSC, 1994)
IRAA	Inhalation rate - adult (m <sup>3</sup> /day)	20	Exposure Factors , EPA 1991 (OSWER No. 9285.6-03)
IRSo	Soil ingestion - occupational (mg/day)	50	Exposure Factors , EPA 1991 (OSWER No. 9285.6-03)
EFo	Exposure frequency - occupational (d/y)	250	Exposure Factors , EPA 1991 (OSWER No. 9285.6-03)
EDo	Exposure duration - occupational (years)	25	Exposure Factors , EPA 1991 (OSWER No. 9285.6-03)

PEF	Particulate emission factor (m <sup>3</sup> /kg) calc.	Soil Screening Guidance (EPA 1996c,d)
VF <sub>s</sub>	Volatilization factor for soil (m <sup>3</sup> /kg) calc.	Soil Screening Guidance (EPA 1996c,d)
sat	Soil saturation concentration (mg/kg) calc.	Soil Screening Guidance (EPA 1996c,d)

Fig. 8.2. Equations for RBC Derivation

### Commercial/Industrial Soil Ingestion

#### Carcinogens

$$RBC \frac{mg}{kg} = \frac{TR \cdot BW_a \cdot AT_c}{EF_o \cdot ED_o \cdot \frac{IRSa}{10^6 \frac{mg}{kg}} \cdot FC \cdot CPS_o}$$

#### Noncarcinogens

$$RBC \frac{mg}{kg} = \frac{THQ \cdot RfD_o \cdot BW_a \cdot AT_n}{EF_o \cdot ED_o \cdot \frac{IRSa}{10^6 \frac{mg}{kg}} \cdot FC}$$

Fig. 8.3. Equations for PRG Derivation

### Combined Exposures to Carcinogenic Contaminants in Industrial Soil

$$C(mg/kg) = \frac{TR \times BW_a \times AT_c}{EF_o \times ED_o \left[ \left( \frac{IRSo \times CSF_o}{10^6 mg/kg} \right) + \left( \frac{SA_a \times AF \times ABS \times CSF_o}{10^6 mg/kg} \right) + \left( \frac{IRA_a \times CSF_i}{VF_s^a} \right) \right]}$$

### Combined Exposures to Noncarcinogenic Contaminants in Industrial Soil

$$C(mg/kg) = \frac{THQ \times BW_a \times AT_n}{EF_o \times ED_o \left[ \left( \frac{1}{RfD_o} \times \frac{IRSo}{10^6 mg/kg} \right) + \left( \frac{1}{RfD_o} \times \frac{SA_a \times AF \times ABS}{10^6 mg/kg} \right) + \left( \frac{1}{RfD_i} \times \frac{IRA_a}{VF_s^a} \right) \right]}$$

Footnote:

<sup>a</sup>Use VF<sub>s</sub> for volatile chemicals (defined as having a Henry's Law Constant [atm-m<sup>3</sup>/mol] greater than 10<sup>-5</sup> and a molecular weight less than 200 grams/mol) or PEF for nonvolatile chemicals.



## Industrial soil exposure

The industrial soil equations in Fig. 8.2 and Fig. 8.3 are standard equations for derivation of an RBC or PRG and no age-adjusted factors are necessary as the population consists entirely of adults.

### 8.2.3 Toxicity Assessment

To understand the possible health risks associated with a potentially hazardous chemical, information on the chemical-specific toxicity is required. Toxicity information is used in conjunction with the results of the exposure assessment to characterize potential health risks. The USEPA provides information on the toxicity of chemicals in two forms: for carcinogens, a cancer slope factor (CSF) is used to describe the dose-response relationship; for noncarcinogenic toxicants, a threshold or reference dose is used to describe the dose above which adverse health effects may be observed. For carcinogens, the endpoint of concern is always cancer. For noncarcinogens, the toxic endpoint (e.g., kidney effects) may vary among chemicals and routes of exposure (e.g., ingestion and inhalation).

#### 8.2.3.1 Toxicity Values

The process used by the USEPA to evaluate potential chemical carcinogens assumes that no threshold levels exist below which a carcinogen will not cause cancer; that is, any exposure to a carcinogen results in the possibility of cancer. This assumption is conservative because many potential human carcinogens, especially chlorinated solvents, appear to be cancer promoters and will increase the possibility of contracting cancer only in the presence of a cancer initiator. Using the no-threshold linearized multistage model, the USEPA determines slope factors to describe the potency of a carcinogen. A large slope factor indicates a high potency. In addition, the USEPA qualitatively evaluates potential carcinogens according to weight-of-evidence from epidemiological studies and animal studies. The USEPA has categorized carcinogens into the following classes:

- Class A: human carcinogen;
- Class B1: probable human carcinogen, limited evidence of carcinogenicity from epidemiological studies;
- Class B2: probable human carcinogen, sufficient evidence in animals, inadequate evidence in humans;
- Class C: possible human carcinogen, limited evidence in animals; and
- Class D: not classifiable.

In general, it is assumed that for noncancer-causing toxicants, a threshold intake exists below which no toxic effects can be seen. This intake, or dose, can be determined by reviewing data from human exposure (usually in an occupational setting) or animal exposure to chemicals. From these studies, no observed adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) can be determined. After NOAEL or LOAEL doses have been established, the USEPA applies uncertainty factors to ensure the safety of human health. Uncertainty factors of 10 each may be applied if the NOAEL study is an animal study, if a subchronic study is used to understand chronic exposure to protect sensitive human populations, and if a LOAEL is used in lieu of a NOAEL.

The Region III RBC table (USEPA 1996d) contains reference doses and carcinogenic potency slope factors (obtained from IRIS through April 1, 1996, HEAST, the EPA-NCEA Superfund Health Risk Technical Support Center, and other EPA sources) and the Region IX PRGs (USEPA 1996e) table contains reference doses and carcinogenic potency slope factors (obtained from IRIS through September 1, 1996, and HEAST, the EPA-NCEA Superfund Health Risk Technical Support Center, and other EPA sources).

#### **8.2.4 Risk Characterization**

The toxicity values are combined with "standard" exposure scenarios to calculate the Region III RBCs and Region IX PRGs, which are chemical concentrations corresponding to fixed levels of risk. Maximum contaminant concentrations in each medium are compared to RBCs and PRGs to determine if the chemical concentrations pose a potential risk to identified receptors. If none of the site concentrations for any chemical exceed their respective RBCs or the PRG, then a no-further-action decision may be supported. However, if some site concentrations do exceed either the RBC or the PRG, a remedial action is not necessarily warranted; but further investigation or a more site-specific evaluation may be needed to reach a decision. These values are also presented in the risk characterization tables for each site. The decision to proceed must also consider project action goals as well as the distribution of contamination.

Throughout the PRE, the expected current and future land use for soils is industrial. Therefore, soil concentrations will be compared to industrial soil RBCs and PRGs. Sediment concentrations will also be compared to industrial soil RBCs and PRGs.

#### **8.2.5 Uncertainty Assessment**

Uncertainties that apply to all sites in the RI are discussed here. Site-specific uncertainties are discussed in the appropriate site PREs sections.

Uncertainty associated with predicting future land use at these sites represents an uncertainty that would have to be considered if the land use ever deviates from industrial. The assumptions for predicting exposure under these conditions could be over- or underestimated should land use change.

The toxicological parameters used to quantify potential risk to a receptor include CSFs and reference doses (RfDs). These values are often derived from laboratory animals studies. The overriding uncertainties associated with the use of laboratory animals studies are:

- the extrapolation of toxic effects observed at the high dose necessary to conduct animal studies to effects that might occur at the much lower, environmentally relevant doses and;
- the extrapolation from toxic effects in animals to toxic effects in man (i.e., response of animals may be different from responses of man).

The USEPA has derived CSFs using a weight-of-evidence approach for studies in the scientific literature. The CSFs represent the upper 95% confidence limits on the slope of the dose-response curve for carcinogenic responses. Because CSFs represent the near upper limits of the slope of the line, the CSF is more likely to overestimate the actual risk than underestimate it.

Uncertainties also arise in the development of RfDs used to characterize noncarcinogenic effects. These reference values are derived using studies in humans or animals by identifying the LOAEL or NOAEL. Two basic types of uncertainty arise. The first is related to the extrapolation from toxic effects seen at high doses to predict effects at the low doses usually encountered in the environment. The second involves extrapolation from effects in animals to effects in man. Each of these is offset by an uncertainty factor that is actually a product of as many as five separate factors, each intended to account for one type of uncertainty (USEPA 1989a). The LOAEL or NOAEL is divided by this composite uncertainty factor. The uncertainty factors usually range from 10 to 10,000. The five types of uncertainties (each representing an uncertainty factor of 5 to 10) included in the assessment of the uncertainty factor are:

- sensitive subpopulations in the general population,
- extrapolation from animals to humans,
- extrapolation from a subchronic study to a chronic estimate,
- extrapolation from a LOAEL to a NOAEL, and
- additional uncertainties in the critical study used in setting the RfD or RfC.

Seven PAHs are classified as Group B2 carcinogens. However, a CSF has been developed for only one of these compounds, benzo(a)pyrene, which is the most potent carcinogen. This CSF is used in the estimating risk for the other potentially carcinogenic PAHs using relative potency values (USEPA 1993).

The inability to quantitatively evaluate compounds lacking toxicity values results in an underestimation of risk.

The use of purposive (biased) sampling by targeting hot spots or areas of known contamination results in the potential for overestimation of risk for the area.

Some potential exposure pathways are not considered in the development of the RBCs. Exclusion of these pathways results in the potential to underestimate risk.

### **8.3 ECOLOGICAL PRELIMINARY RISK EVALUATION APPROACH**

No ecological risk assessment was conducted because of the lack of receptor habitat and receptor exposure to contaminants of potential concern. See Sect. 8.2.2.1.

### **8.4 SITE PRELIMINARY RISK EVALUATIONS**

#### **8.4.1 IRP Site 1 Current Fire Training Area**

IRP Site 1, the Current Fire Training Area, was sampled for potential groundwater contamination. No other media are considered in this PRE, based on the results of previous investigations (SI 1992) and a source removal action of contaminated soils (AGI 1995). As stated in the methodology section, Sect. 8.2.2.2, only groundwater is of concern at this site. No PRE is performed because no contamination was found above State or Federal ARARs. In addition, there is a lack of a potential receptor.

## **8.4.2 Site 6, Aerospace Ground Equipment Area**

IRP Site 6, the Aerospace Ground Equipment Area, was sampled for potential groundwater, soil (surface and subsurface), and sediment contamination based on the results of previous investigations (HAZWRAP 1992). As stated in the methodology, Sect. 8.2, only a human health PRE is performed for this site.

### **8.4.2.1 Identification of Chemicals of Potential Concern**

The criteria described in Sect. 8.2.1 were applied to develop the list of chemicals of potential concern for Site 5. Soil COPCs selected include 12 VOCs, 6 SVOCs, and TPH. Table 8.3 lists these COPCs. Sediment COPCs selected include four VOCs, nine SVOCs, and three inorganics. Table 8.4 lists these COPCs.

### **8.4.2.2 Exposure Evaluation**

**Characterization of Exposure Setting.** IRP Site 6 is the AGE Maintenance Shop, Building 22, located between Buildings 20, 21, 23, and 24 within the industrial area of the Base. A ditch runs along the east side of the building. The entire site is paved except for the ditch. From 1962 to 1978, approximately 17,000 gal of POL waste, hydraulic fluid, and solvents were discharged to a 3-ft diameter, brick-lined dry well located adjacent to the southwest side of the building. Small amounts of waste were reported to have been discharged to the ditch located southeast of Building 22.

Topography at the site is relatively flat. A storm drainage ditch runs along the eastern side of Building 22 and flows in the northeast direction. Groundwater flow is to the northwest, and average depth to the water table is 45–50 ft bgs.

**Current land use and potentially exposed population.** This site is currently characterized as industrial in nature and use. Base personnel may be exposed to soil contamination at the site. The facility is within a secured zone, and trespassers are unlikely to intrude. Because the Base receives its water from the city and no impacts to domestic or municipal wells have been identified, no current groundwater exposures exist.

**Future land use and potentially exposed populations.** It is anticipated that this site will remain an industrial use facility for the foreseeable future. Therefore, future exposures to surface and subsurface soils and sediments will be the same as current exposures. Future potential downgradient receptors would not be affected by groundwater migrating from the site because current investigations indicated the groundwater was not contaminated above State and Federal ARARs. Domestic wells exist within a 2-mile radius of the Base but are not located downgradient of the site.

### **8.4.2.3 Identification of Exposure Pathways**

Potential soil exposure pathways include ingestion, inhalation, and dermal contact with surface and subsurface soils and sediment through industrial activities. No other media exposure pathways exist.

Table 8.3 IRP Site No. 6 Soil Initial List of Contaminants of Potential Concern and Risk-Based Screening Results  
Current and Future Land Use 120th FIG, Montana ANG, Great Falls, Montana

Contaminants of Potential Concern	Maximum Detection Concentration (mg/kg)	Frequency of Detection	Region 3 RBC (mg/kg)	Exceed RBC?	Region 9 PRG (mg/kg)	Exceed PRG?	Contaminant of Potential Concern?
<b>Volatiles</b>							
1,2-Dichloroethene	0.350	1/8	18000.00	nc	120.00	nc	n
2-Butanone	0.043	5/8	1000000.00	nc	27000.00	nc	n
2-Hexanone	0.005	3/8	na	na	na	na	na
4-Methyl-2-Pentanone	0.011	1/8	na	na	na	na	na
Acetone	2.000	6/8	200000.00	nc	8800.00	nc	n
Carbon Disulfide	0.002	1/8	200000.00	nc	24.00	nc	n
Chloroform	0.001	1/8	940.00	ca	0.53	ca	n
Ethylbenzene	5.900	4/8	200000.00	nc	230.00	sat	n
Methylene Chloride	0.250	1/8	760.00	ca	18.00	ca	n
Toluene	60.000	2/8	410000.00	nc	880.00	sat	n
Trichloroethene	0.280	1/8	520.00	ca	7.00	ca	n
Xylene	37.000	4/8	1000000.00	nc	320.00	sat	n
<b>Semi-Volatiles</b>							
2-Methylnaphthalene	12.000	3/8	na	na	na	na	na
Bis(2-Ethylhexyl)phthalate	2.900	3/8	410.00	ca	140.00	ca	n
Di-n-butylphthalate	0.220	2/8	200000.00	nc	68000.00	nc	n
Di-n-octylphthalate	0.050	2/8	41000.00	nc	10000.00	sat	n
Fluorene	0.040	1/8	82000.00	nc	90.00	sat	n
Naphthalene	11.000	3/8	82000.00	nc	240.00	sat	n
<b>Petroleum Hydrocarbon</b>							
JP-4	5.700	4/8	100.00	1	n		n
Diesel Range, as diesel	1.900	5/8	100.00	1	n		n
Oil Range, as oil	10.000	3/8	100.00	1	n		n
Gasoline Range	0.29	1/8	100.00	1	n		n

Notes:

n = no exceedance

y = exceedance

na = not available

1 = 100 ppm criteria from Montana UST petroleum guidelines

PRG = Preliminary Remediation Goal

ca = cancer risk based concentration

nc = noncancer risk based concentration

sat = saturated soil value

max = maximum soil value

RBC = Risk based concentration

Table 8.4 IRP Site No. 6 Sediment Initial List of Contaminants of Potential Concern and Risk-Based Screening Results  
Current and Future Land Use 120th FIG, Montana ANG, Great Falls, Montana

Contaminants of Potential Concern	Maximum Detection Concentration (mg/kg)	Frequency of Detection	Region 3 RBC (mg/kg)	Exceed RBC?	Region 9 PRG (mg/kg)	Exceed PRG?	Contaminant of Potential Concern?
<b>Volatiles</b>							
2-Hexanone	0.008	3/3	na	na	na	na	n
4-Methyl-2-Pentanone	0.005	1/3	na	na	na	na	n
Carbon Disulfide	0.001	1/3	200000.00	nc	24.00	nc	n
Methylene Chloride	0.003	3/3	760.00	ca	18.00	ca	n
<b>Semi-Volatiles</b>							
Benzo(b)fluoranthene	0.660	3/3	7.80	ca	2.60	ca	n
Benzo(k)fluoranthene	0.660	3/3	78.00	ca	26.00	ca	n
Benzo(a)pyrene	0.380	1/3	0.78	ca	0.26	ca	y
Benzo(g,h,i)perylene	0.620	2/3	-	na		na	na
Chrysene	0.490	2/3	780.00	ca	7.20	sat	n
Di-n-butylphthalate	0.130	1/3	200000.00	nc	68000.00	nc	n
Fluoranthene	0.220	2/3	82000.00	nc	27000.00	nc	n
Indeno(1,2,3-c,d)pyrene	0.110	1/3	7.80	nc	2.60	ca	n
Pyrene	0.490	3/3	61000.00	nc	100.00	sat	n
<b>Inorganics</b>							
Cadmium	11.900	3/3	1000.00	nc	850.00	nc	n
Lead	758.000	3/3	-	na	1000.00	nc	n
Silver	1.600	1/3	10000.00	nc	8500.00	nc	n

Notes:

n = no exceedence

y = exceedence

na = not available

1 = 100 ppm criteria from Montana UST petroleum guidelnes

PRG = Preliminary Remediation Goal

ca = cancer risk based concentration

nc = noncancer risk based concentration

sat = saturated soil value

max = maximum soil value

RBC = Risk based concentration

#### **8.4.2.4 Quantification of Exposure**

As explained in the methodology for the human health PRE, Sect. 8.2.2.3, the Region III RBCs are based on exposure through the ingestion route only. However, Region IX PRGs do include both inhalation and dermal contact as well as ingestion exposures from soils. Therefore, all exposure routes were considered in this PRE.

#### **8.4.2.5 Toxicity Assessment**

The toxicity assessment for PREs is described in Sect. 8.2.3. All COPCs had toxicity values available for use within the PRE for Site 6 except 2-hexanone, 4-methyl-2-pentanone, benzo(g,h,i)perylene, 2-methylnaphthalene, and TPH. Although TPH does not have associated toxicity values, the State of Montana does have a cleanup guideline for petroleum releases of 100 parts per million (ppm) (Montana DEQ 1996).

#### **8.4.2.6 Risk Characterization**

The maximum detected concentrations of all soil COPCs were compared to industrial soil RBCs and PRGs, and any exceedances of these criteria were identified (Table 8.3). No compound maximum detected concentrations exceeded the soil RBCs or PRGs. The maximum detected concentrations of all sediment COPCs were compared to soil industrial RBCs and PRGs, and any exceedances of these criteria were identified (Table 8.4). With the exception of benzo(a)pyrene, no contaminants exceed the Region IX PRGs. The detected concentration of benzo(a)pyrene was 1.4 times the Region IX PRG. The detected concentration of benzo(a)pyrene is still within the  $10^{-6}$  risk range and should not pose an unacceptable human health risk.

#### **8.4.2.7 Uncertainty Assessment**

It is likely the risk from benzo(a)pyrene is overestimated as a result of the conservative nature of the parameters used to calculate Region IX PRGs. Because of the small margin of exceedance and the nature of the activity at the site, it is unlikely that the detected concentration of benzo(a)pyrene poses an unacceptable human health risk.

### **8.4.3 Site 7, Dry Well Off Corrosion Control Building**

IRP Site 7, the Dry Well Off Corrosion Control Building, was sampled for potential groundwater, surface soil, and subsurface soil contamination based on the results of previous investigations (HAZWRAP 1992). As stated in the methodology, Sect. 8.2, only a human health PRE is performed for this site.

#### **8.4.3.1 Identification of Chemicals of Potential Concern**

The criteria described in Sect. 8.2.1 were applied to develop the list of COPCs for Site 7. Soil COPCs selected include 12 VOCs, 8 SVOCs, and TPH. Table 8.5 lists these COPCs.

Table 8.5 IRP Site No. 7 Soil Initial List of Contaminants of Potential Concern and Risk-Based Screening Results  
Current and Future Land Use 120th FIG, Montana ANG, Great Falls, Montana

Contaminants of Potential Concern	Minimum Detection Concentration (mg/kg)	Frequency of Detection	Region 3 RBC (mg/kg)	Exceed RBC?	Region 9 PRG (mg/kg)	Exceed PRG?	Contaminant of Potential Concern?
<b>Volatiles</b>							
2-Butanone	0.057	7/11	1000000.00	nc	27000.00	nc	n
2-Hexanone	0.007	2/11	na	na	na	na	na
4-Methyl-2-Pentanone	0.019	1/11	na	na	na	na	na
Acetone	1.800	10/11	200000.00	nc	8800.00	nc	n
Benzene	0.830	2/11	200.00	ca	1.40	ca	n
Carbon Disulfide	0.002	2/11	200000.00	nc	24.00	nc	n
Chloroform	0.730	3/11	940.00	ca	0.53	ca	y
Ethylbenzene	13.000	5/11	200000.00	n	230.00	sat	n
Methylene Chloride	0.026	1/11	760.00	ca	18.00	ca	n
Toluene	5.700	5/11	410000.00	nc	880.00	sat	n
Trichloroethene	0.004	1/11	520.00	ca	7.00	ca	n
Xylene	80.000	6/11	1000000.00	nc	320.00	sat	n
<b>Semi-Volatiles</b>							
2-Methylnaphthalene	5.100	6/11	na	na	na	na	na
Bis(2-Ethylhexyl)phthalate	0.920	5/11	410.00	ca	140.00	ca	n
Di-n-octylphthalate	0.043	1/11	41000.00	nc	10000.00	sat	n
Flouranthene	0.017	1/11	82000.00	nc	27000.00	nc	n
Fluorene	0.063	4/11	82000.00	nc	90.00	sat	n
Naphthalene	3.300	6/11	82000.00	nc	240.00	sat	n
Phenanthrene	0.170	4/11	na		na	na	na
Pyrene	0.019	2/11	61000.00	nc	100.00	sat	n
<b>Petroleum Hydrocarbon</b>							
JP-4	950.000	4/11	100.00	1	y		y
Diesel Range, as diesel	900.000	6/11	100.00	1	y		y
Oil Range, as oil	8900.000	6/11	100.00	1	y		y

Notes:

n = no exceedence

y = exceedence

na = not available

1 = 100 ppm criteria from Montana UST petroleum guidleines

PRG = Preliminary Remediation Goal

ca = cancer risk based concentration

nc = noncancer risk based concentration

sat = saturated soil value

max = maximum soil value

RBC = Risk based concentration



#### 8.4.3.2 Exposure Evaluation

**Characterization of Exposure Setting.** Site 7 is a dry well located within 10 ft of the northwest wall of Building 23. This well is currently covered by lawn. From 1955 to 1964, approximately 9,400 gal of motor pool waste oils and fuels were disposed of via an underground pipe to the dry well.

Topography of the site is relatively flat with a drainage ditch located to the west and flows to the southwest.

Groundwater flow is to the northwest and the water table is between 45–50 ft bgs.

**Current land use and potentially exposed population.** This site is currently characterized as industrial in nature but has no current use. Therefore, no current soil exposures are expected because of the lack of use and the gravel cover. The facility is within the Base and trespassers are unlikely to intrude. Because the Base receives its water from the city and no impacts to domestic or municipal wells have been identified, no current groundwater exposures exist either.

**Future land use and potentially exposed populations.** It is anticipated that this site will remain an industrial use facility for the foreseeable future. Therefore, future exposures to surface and subsurface soils may include industrial workers coming in contact with media at the site. Groundwater migrating from the site could potentially impact downgradient domestic or municipal wells in the future, but as there are no active wells downgradient of the site this scenario is unlikely. In addition, a monitoring well (7MW-3) installed downgradient of the site was found to have no contaminants above State or Federal ARARs. There are domestic wells within a 2-mile radius of the Base, but these are located upgradient and cross-gradient of the site. Therefore, the potential for future groundwater exposures via residential use were not evaluated.

#### 8.4.3.3 Identification of Exposure Pathways

Potential soil exposure pathways include ingestion, inhalation, and dermal contact with surface and subsurface soils through industrial activities.

#### 8.4.3.4 Quantification of Exposure

As explained in the methodology for the human health PRE, Sect. 8.2.2.3, the Region III RBCs are based on exposure through the ingestion route only. However, Region IX PRGs do include both inhalation and dermal contact as well as ingestion exposures from soils. Therefore, all exposure routes were considered in this PRE.

#### 8.4.3.5 Toxicity Assessment

The toxicity assessment for PREs is described in Sect. 8.2.3. All COPCs had toxicity values available for use within the PRE for Site 7 except 2-hexanone, 4-methyl-2-pentanone, 2-methylnaphthalene, phenanthrene, and TPH. Although TPH does not have associated toxicity values, the State of Montana does have a cleanup guideline for petroleum releases of 100 ppm (Montana DEQ 1996).

#### 8.4.3.6 Risk Characterization

The maximum detected concentrations of all soil COPCs were compared to industrial soil RBCs and PRGs, and any exceedances of these criteria were identified (Table 8.5). With the exception of chloroform, no contaminants exceed the Region IX PRGs. The detected concentrations of chloroform were 1.34 times the Region IX PRG. The detected concentration of chloroform is still within the  $10^{-6}$  risk range and should not pose an unacceptable human health risk.

Maximum concentrations of TPH at Site 7 exceed Montana UST petroleum release criterion of 100 ppm.

#### 8.4.3.7 Uncertainty Assessment

TPH does not have associated toxicity values and could not be evaluated on a health risk basis. Uncertainty that could underestimate the overall risk is associated with the inability to evaluate the TPH detected at this site. It is likely the risk from chloroform is overestimated because of the conservative nature of the parameters used to calculate Region IX PRGs. Because of the small margin of exceedance and the nature of the activity at the site, it is unlikely that the detected concentration of chloroform poses an unacceptable human health risk. Chloroform may not be site related. Chloroform is a breakdown product of naturally occurring organic material.

#### 8.4.4 Site 8, Dry Well Off Composite Maintenance Building

IRP Site 8, the Dry Well Off Composite Maintenance Building, was sampled for potential groundwater contamination based on the results of previous investigations (HAZWRAP 1992). As stated in the methodology, Sect. 8.2, only a human health PRE is performed for this site.

##### 8.4.4.1 Identification of Chemicals of Potential Concern

The criteria described in Sect. 8.2.1 were applied to develop the list of COPCs for Site 8. Groundwater COPCs selected include 11 VOCs, 5 SVOC, and TPH. Table 8.6 lists these COPCs.

##### 8.4.4.2 Exposure Evaluation

**Characterization of Exposure Setting.** IRP Site 8 is located between Buildings 30 and 32 and within the industrial area of the Base. From 1971 to 1977, small amounts of waste engine oil, hydraulic fluids, paint strippers and thinners, JP-4, and PD-680 were deposited in the dry well. The dry well is currently paved over with asphalt.

The water table is estimated to occur at a depth of 45 to 50 ft bgs with groundwater flow to the northwest.

**Current land use and potentially exposed population.** This site is currently characterized as industrial in nature but has no specific current use. Because the Base receives its water from the

Table 8.6 IRP Site No. 8 Soil Initial List of Contaminants of Potential Concern and Risk-Based Screening Results  
Current and Future Land Use 120th FIG, Montana ANG, Great Falls, Montana

Contaminants of Potential Concern	Maximum Detection Concentration (mg/kg)	Frequency of Detection	Region 3 RBC (mg/kg)		Exceed RBC?	Region 9 PRG (mg/kg)		Exceed PRG?	Contaminant of Potential Concern?
<b>Volatiles</b>									
1,2 - Dichloroethene	0.086	3/15	18000.00	nc	n	120.00	nc	n	n
2-Butanone	0.093	12/15	1000000.00	nc	n	27000.00	nc	n	n
2-Hexanone	0.018	9/15	na			na	na	na	na
4-Methyl-2-Pentanone	0.025	4/15	na			na	na	na	na
Acetone	0.950	14/15	200000.00	nc	n	8800.00	nc	n	n
Carbon Disulfide	0.001	7/15	200000.00	nc	n	24.00	nc	n	n
Ethylbenzene	0.250	2/15	200000.00	nc	n	230.00	sat	n	n
Methylene Chloride	0.090	2/15	760.00	ca	n	18.00	ca	n	n
Toluene	0.420	6/15	410000.00	nc	n	880.00	sat	n	n
1,1,2 - Trichloroethane	0.001	1/15	520.00	ca	n	1.50	ca	n	n
Xylene	1.900	11/15	1000000.00	ca	n	320.00	sat	n	n
<b>Semi-Volatiles</b>									
2-Methylnaphthalene	0.220	1/15	na						
Bis(2-Ethylhexyl)phthalate	0.980	5/15	410.00	na	n	140.00	ca	n	n
Di-n-butylphthalate	0.026	3/15	200000.00	ca	n	68000.00	nc	n	n
Di-n-octylphthalate	0.014	4/15	41000.00	nc	n	10000.00	sat	n	n
Naphthalene	0.380	1/15	82000.00	nc	n	240.00	sat	n	n
<b>Petroleum Hydrocarbon</b>									
JP-4	240.000	1/15	100.00	1	y				y
Diesel Range, as diesel	340.000	1/15	100.00	1	y				y
Oil Range, as oil	1700.000	2/15	100.00	1	y				y
Gasoline Range	1200.00	1/15	100.00	1	y				y

Notes:

n = no exceedence

y = exceedence

na = not available

1 = 100 ppm criteria from Montana UST petroleum guidelines

PRG = Preliminary Remediation Goal

ca = cancer risk based concentration

nc = noncancer risk based concentration

sat = saturated soil value

max = maximum soil value

RBC = Risk based concentration

city and no impacts to domestic or municipal wells have been identified, no current groundwater exposures exist.

**Future land use and potentially exposed populations.** It is anticipated that this site will remain an industrial use facility for the foreseeable future. Groundwater migrating from the site could potentially impact downgradient domestic or municipal wells in the future, but as there are no active wells downgradient of the site this scenario is unlikely. There are domestic wells within a 2-mile radius of the Base, but these are located upgradient and cross-gradient of the site. Therefore, the potential for future groundwater exposures via residential use were not evaluated.

#### **8.4.4.3 Identification of Exposure Pathways**

Potential soil exposure pathways include ingestion, inhalation, and dermal contact through domestic use.

#### **8.4.4.4 Quantification of Exposure**

As explained in the methodology for the human health PRE, Sect. 8.2.2.3, the Region III RBCs are based on exposure through the ingestion route only. However, Region IX PRGs do include both inhalation and dermal contact as well as ingestion exposures from soils. Therefore, all exposure routes were considered in this PRE.

#### **8.4.4.5 Toxicity Assessment**

The toxicity assessment for PREs is described in Sect. 8.2.3. All COPCs had toxicity values available for use within the PRE for Site 8 except 2-hexanone, 4-methyl-2-pentanone, 2-methylnaphthalene, and TPH. Although TPH does not have associated toxicity values, the State of Montana does have a cleanup guideline for petroleum releases of 100 ppm (Montana DEQ 1996).

#### **8.4.4.6 Risk Characterization**

The maximum detected concentrations of all soils COPCs were compared to industrial RBCs and PRGs, and any exceedances of these criteria were identified (Table 8.6). None of the compounds maximum concentrations exceed the screening criteria. Maximum concentrations of TPH did exceed the Montana cleanup guideline of 100 ppm.

#### **8.4.4.7 Uncertainty Assessment**

TPH does not have associated toxicity values and could not be evaluated on a health risk basis. Uncertainty that could underestimate the overall risk is associated with the inability to evaluate the TPH detected at this site.

### **8.5 PRELIMINARY RISK ASSESSMENT SUMMARY**

The following paragraphs provide a summary of detected compounds at the three sites; a listing of these compounds is provided in Table 8.7

Table 8.7 Summary of Human Health RBC Screening 120th Fighter Interceptor Group, Montana, ANG  
Great Falls International Airport, Great Falls, Montana

Site	Contaminants of Potential Concern	Maximum Detection Concentration	Frequency of detection	Risk Based Concentration	Cancer or Noncancer ?
No. 6					
Soil (mg/kg)	none exceeded				
Sediment (mg/kg)					
	Benzo(a)pyrene	0.380	1/3	0.26	ca
No. 7					
Soil (mg/kg)					
	Chloroform	0.730	3/11	0.53	ca
	TPH	8900	6/11	100	soil guidance level
No. 8					
Soil (mg/kg)					
	TPH	1700	2/15	100	soil guidance level

**Site 6 - Aerospace Ground equipment Area.** The PRE for the soils at Site 6 indicates the concentrations in the soils do not exceed criteria for threats to human health. With the exception of benzo(a)pyrene, the PRE for sediments at Site 6 indicated the detected contaminant concentrations do not exceed the PRE criteria. Detected concentrations of benzo(a)pyrene slightly exceed the Region IX PRG by less than 1.5 times, which is still within the  $10^{-6}$  range and should not pose an unacceptable human health risk. The soils at the site are paved over except for the sediments in the ditch.

**Site 7 - Dry Well Off Corrosion Control Building.** With the exception of chloroform, the PRE for soils at Site 7 indicated the detected contaminant concentrations do not exceed the Region IX PRG by less than 1.5 times, which is still within the  $10^{-6}$  range and should not pose an unacceptable human health risk. However, maximum concentrations of TPH do exceed the Montana cleanup guidelines for petroleum and could be a continuing source of contamination to the groundwater. Benzene and other petroleum-related compounds do exceed the MCLs and MDEQs criteria in the groundwater at this site.

**Site 8 - Dry Well Off Composite Maintenance Building.** The PRE for the soils at Site 8 indicates the maximum concentrations of contaminants in the soils do not exceed the health risk criteria. However, maximum concentrations of TPH do exceed the Montana cleanup goal guidelines for petroleum and could be a continuing source of contamination to the groundwater.

## 9. CONCLUSIONS

### 9.1 GEOLOGIC AND HYDROGEOLOGIC CONCLUSIONS

As a result of the activities conducted during the RI at the Base at Great Falls, conclusions are made that pertain to the geologic conditions and hydrogeologic processes affecting the vadose and saturated zones at the Base. The following geologic and hydrogeologic conclusions are summarized below:

- The thickness of the zone of soil and weathered bedrock varies across the Base from approximately 2.5 ft to as much as 20 ft. An average thickness of 8 to 10 ft of overburden of soil and weathered rock is estimated before competent bedrock is encountered.
- The lithology of the interval below the soil and weathered rock consists predominantly of fine-grained sandstone with minor siltstone beds. At around 45 ft bgs a characteristic color change from mainly red-brown sandstones to dark gray sandstones occurs and marks the top of the main aquifer. Porosity and permeability of this section are low and correspondingly affect the entry of groundwater into monitoring wells.
- Depth to groundwater varies from approximately 45 to 50 ft bgs. The overall Basewide flow of groundwater is in a west to west-northwest direction. As discussed in Sect. 5.1.2, changes in the matrix and cement of the bedrock sandstone may be responsible for localized variations in groundwater flow patterns.
- Hydraulic conductivities derived from slug testing at the sites averaged  $2.38\text{E-}2$  ft/min. This value appears higher than anticipated in view of the tight nature of the sequence drilled and is believed to reflect the fractured nature of the bedrock. Because of this, groundwater flow velocities based on the slug test data are believed not to be representative of site conditions.

### 9.2 SITE 1 CONCLUSIONS

- Groundwater elevations from the wells and piezometers at Site 1 support that the location of 1MW-2 is downgradient from 1MW-1. The water level data from 1MW-1, however, are considered anomalous.
- The analytical results from groundwater sampling at 1MW-2 detected only very-low-level organic and metal contaminants similar to the results of 1MW-1. All detections in both wells from both sampling events were below State and Federal ARARs.

### 9.3 SITE 6 CONCLUSIONS

The following conclusions are made concerning the soil, sediment/surface soil, and groundwater contamination present at Site 6. Additional conclusions are reached regarding the presumed Site 6 dry well and location.

### 9.3.1 Soil Contamination

- VOCs, SVOCs, petroleum hydrocarbons, and metals were detected in the soil and weathered bedrock at Site 6. The highest concentrations of contaminants were found in the boring that was advanced at the location of the Site 6 dry well. Relatively high levels were also detected at SB17, adjacent to the area of the dry well. Concentrations found at refusal in the boring located inside the hanger (Building 25) indicate the presence of SVOCs.

Soils in the vicinity of the dry well are paved over with asphalt or beneath buildings. The PRE performed for soils at the site and presented in Sect. 8, however, indicate the concentrations of contaminants in the soil and expected exposure scenarios do not exceed criteria for threats to human health.

### 9.3.2 Sediment/Surface Soil Contamination

- Low-level concentrations of VOCs along with SVOCs, petroleum hydrocarbons, and above-background concentrations of metals were detected in sediments sampled in the drainage ditch at Site 6. One compound found, benzo(a)pyrene, found at a maximum concentration of 0.38 ppm exceeded the Region IX PRG of 0.26 ppm and is, therefore, classified by the PRE as a COPC to human health.

### 9.3.3 Groundwater Contamination

- Groundwater sampling of the Site 6 monitoring wells detected numerous low-level concentrations of volatile contaminants; semivolatile contaminants were all nondetects or estimated concentrations of 0.001 ppm. VOC and SVOC compounds detected did not exceed Federal or State ARARs. Petroleum hydrocarbons were detected but were at low levels. None of the metals detected were at concentrations above State or Federal MCLs and were representative of background conditions.

### 9.3.4 Other Site 6 Conclusions

- At Site 6 the groundwater flow direction is predominantly to the north-northwest. Variability in the porosity and permeability of the rock sequence encountered may be responsible for localized variations and a partial groundwater flow divide.
- The boring advanced at the presumed location (determined from the GPR data from the SI) of the Site 6 dry well is concluded to be the correct location. Although no construction material (e.g., bricks, stone, or gravel) was found, the high concentrations of VOCs and SVOCs detected in the samples are considered as verification of the location.
- A range of VOCs, SVOCs, petroleum hydrocarbons, and metals were found in a sample of fluid collected from the oil/water separator. However, based on inspection of "as-built" drawings, the oil/water separator does not appear to be of a construction design that would allow loss of fluids to the surrounding area.



## 9.4 SITE 7 CONCLUSIONS

Conclusions regarding the soil and groundwater contamination at Site 7 are supplied below. In addition to the analytical data, information and conclusions regarding the presence of free product are made.

### 9.4.1 Soil Contamination

- Except for chloroform, none of the levels of VOC and SVOC contamination of soils found at Site 7 exceeded the Region IX PRG. Concentrations of fuel-related VOCs were low except in the samples from the boring closest to the presumed location of the dry well. Fuel-associated SVOC compounds were present, but primarily in the samples taken at auger refusal. This finding was also true for the petroleum hydrocarbons. Four metals (arsenic, copper, lead, and zinc) were detected above background, and two metals (beryllium and mercury) were detected that were not present in the background samples.
- The PRE for the soil at Site 7 indicates chloroform is the only analyte whose concentration exceeds the Region IX PRG. The PRG was calculated based on a target risk value of  $10E-6$ ; at this concentration, the risk is still within the  $10-6$  range. None of the other contaminants exceed the PRE criteria.

### 9.4.2 Groundwater Contamination

- Numerous volatile organic analytes were detected in both rounds of groundwater sampling at Site 7; however, only one VOC analyte was detected at a level above Federal or State MCLs. The analyte above ARARs was benzene at 0.0055 ppm in 7MW-2 (Federal and State MCLs are 0.005 ppm). SVOCs generally were nondetects except in one well that had six PAH compounds detected above State ARARS. These detections were qualified values in the 0.001 to 0.002 ppm range. Eight metals were present in the groundwater, but none of the concentrations exceeded State or Federal MCLs; no direct relationship to site activities can be established.

### 9.4.3 Free Product

- Free product was found in monitoring well 7MW-1 at the beginning of the investigation; the product thickness varied from 1.32 ft to 1.10 ft, after installation of other Site 7 wells. Although contaminants were found in a downgradient well, the only jet fuel component found was a low level of toluene. All detections were below State and Federal MCLs.

## 9.5 SITE 8 CONCLUSIONS

### 9.5.1 Soil Contamination

- VOC, SVOC, petroleum hydrocarbons, and metal contaminants were found in the Site 8 borings. Four metals were detected above background values; three additional metals were present but were within the range of values for corresponding metals in the western United States.

- All the soils within the vicinity of the removed Site 8 dry well are paved with asphalt or covered by buildings. The PRE performed for soils at the site and presented in Sect. 8 indicates the concentrations of contaminants in the soil do not exceed criteria for threats to human health.

#### 9.5.2 Groundwater Contamination

- Results from the groundwater sampling indicated the presence of a variety of chlorinated compounds, three of which were above State and Federal MCLs. Cis-1,2-dichloroethene was detected at a maximum concentration of 0.083 ppm. State and Federal ARARs for this analyte is 0.070 ppm. TCE was detected at a maximum concentration of 0.005 ppm. State and Federal MCLs are 0.005 ppm. Tetrachloroethene was present at a maximum concentration of 0.018 ppm; State and Federal MCLs are 0.005 ppm. In addition to the chlorinated compounds, VOC detections of fuel-related analytes and petroleum hydrocarbons were present; SVOCs were either absent or restricted to potential laboratory contaminants. None of the other VOCs or SVOCs were above State or Federal ARARs. Two metals, mercury and antimony, were detected at concentrations either equal to or above State or Federal ARARs.
- Overall, the groundwater flow direction at Site 8 is to the west, with a northerly component. Because chlorinated organic compounds were detected in the four site wells, mapping of a plume boundary is not possible. Because only one of the soil borings from the RI and one from the SI had detections of chlorinated compounds estimated above 0.001 ppm, the source of the chlorinated compounds in the groundwater may not have been from the dry well before its removal. Alternatively, degradation of the chlorinated analytes may be occurring in the soil and groundwater.

## **10. RECOMMENDATIONS**

### **10.1 SITE 1**

Preparation of a DD to support no further action is recommended. There are no groundwater contaminants shown to be above State or Federal ARARs.

### **10.2 SITE 6**

#### **10.2.1 Soils and Sediments**

- Preparation of a DD to include support for no further investigative action regarding soils is recommended. Subsurface soils at Site 6 are entirely covered with asphalt. The PRE for soils indicates the concentrations of contaminants do not exceed criteria for threats to human health.
- With the exception of benzo(a)pyrene, no contaminants detected in the sediments exceeded the PRE criteria. Detected concentration of benzo(a)pyrene slightly exceed the Region IX PRG by less the 1.5 times, which is still within the  $10^{-6}$  risk range and should not pose an unacceptable human health risk.

#### **10.2.2 Groundwater**

- Preparation of a DD to include support for no further action is recommended for Site 6 groundwater. Groundwater at the site does not appear to be impacted by migration of contaminants from the presumed dry well or other sources. Because of the absence of contamination above State and Federal MCLs, a no-further-action alternative is recommended for the Site 6 groundwater.

#### **10.2.3 Other Site-related Recommendations**

- The contents of the additional possible dry well at the site should be removed and the dry well filled with concrete.

### **10.3 SITE 7**

#### **10.3.1 Soil**

- No further action is recommended for Site 7 soils. With the exception of chloroform, no contaminants exceeded the PRE criteria. Detected concentration of chloroform slightly exceeded the Region IX PRG by 1.5 times, which is still within the  $10^{-6}$  risk range and should not pose an unacceptable human health risk. Four metals were above background, but the PRE indicated soil did not exceed the Region IX PRG. Two additional metals not present in the background samples were within the range of metal concentrations anticipated in the western United States.

### **10.3.2 Groundwater and Free Product**

- It is recommended that a EE/CA be performed to evaluate potential remedial measures at Site 7. This work is recommended to evaluate the lateral and vertical extent of groundwater contamination and the horizontal extent of the free product. Recharge rate of product into the 7MW-1 monitoring well and free product thickness should be measured and an appropriate product-removal pump installed.

## **10.4 SITE 8**

### **10.4.1 Soil**

- No further action for Site 8 soils is recommended. The assumed source of soil contamination at Site 8, the dry well, has been removed and the area of the site is entirely covered with asphalt. The PRE for the soils indicates the concentrations of contaminants do not exceed criteria for threats to human health.

### **10.4.2 Groundwater**

- It is recommended that an EE/CA be performed for evaluation of potential remedial measures at the site. Three chlorinated compounds were detected in the groundwater at Site 8 at levels exceeding State and Federal MCLs; in addition, two metals were detected at concentrations above or equal to State or Federal ARARs. The extent of the contamination to groundwater was not fully evaluated; the installation of additional monitoring wells may be required.

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